2004

Site Environmental Report

BROOKHAVEN NATIONAL LABORATORY

Volume 1

ABOUT THE COVER

The beautiful photograph on the front and back cover of this report was taken by Dr. Tim Green, Natural and Cultural Resources Manager, at Brookhaven National Laboratory (BNL). The cover design and report layout was prepared by Patricia Yalden of the Photography & Graphic Arts Division.

The water lily serenely depicted in this photograph was taken at Zeke's Pond, a coastal plain pond located on site. As part of the recent Peconic River cleanup at BNL, summer intern students relocated fish and wildlife to the pond and its surrounding area, providing them with a pristine and undisturbed environment in which to thrive. Ecology research being conducted at Zeke's pond includes studying its water and soil chemistry, and the make-up of its biotic community.

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2004

Site Environmental Report

BROOKHAVEN NATIONAL LABORATORY

Volume I

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EXPLORING EARTH'S MYSTERIES
...PROTECTING ITS FUTURE

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**A MESSAGE FROM
THE LABORATORY DIRECTOR**

In 2004, the Laboratory made great progress under its environmental management program. BNL's Environmental Management System (EMS) is the Laboratory's commitment to environmentally responsible operations. The cornerstone of an EMS is a Laboratory Environmental Stewardship Policy. In 2004, BNL incorporated the principles of its previous Laboratory-wide Environmental Stewardship Policy into a comprehensive Environmental, Safety, Security, and Health (ESSH) Policy. I signed this policy to make clear BNL's commitments to environmental stewardship, the safety of its employees, and the security of the site. A recertification audit of our EMS in June determined that BNL remains in conformance, and the auditors highlighted five examples of continual improvement since the Laboratory achieved this globally recognized International Organization for Standardization (ISO) 14001 Environmental Management Standard in 2001.

BNL operations led to several awards from a diverse stakeholder group, including an EPA Environmental Quality Award, a DOE Office of Science Best in Class Award, DOE's Pollution Prevention Award, a White House Closing the Circle Award, a DOE Office of Science Pollution Prevention Award, a Long Island Pine Barrens Society Award, and the Evelyn Liblit Environmental Stewardship Award. In addition, the Laboratory was accepted into the EPA's Performance Track Program, which recognizes top environmental performance among participating U.S. facilities. This program is EPA's "gold standard" for facility-based environmental performance. I am proud of these achievements, which represent additional evidence that the Laboratory's EMS is working.

BNL's pollution prevention program continues to be a success. To date, pollution prevention projects have saved more than \$1.6 million and resulted in the reduction or reuse of approximately 2.2 million pounds of waste. In 2004, the Laboratory invested approximately \$86,000 in eight new pollution prevention proposals, which are expected to save the Laboratory approximately \$60,500 annually, for an average payback period of 1.3 years.

In 2004, BNL continued to clean up contaminated soil and groundwater on site. Since the beginning of active groundwater remediation in 1996, the Laboratory has removed 4,808 pounds of chemicals from the aquifer by treating approximately 8.4 billion gallons of groundwater.

Under the Laboratory's Environmental Restoration Program, legacy issues continue to be addressed. With the input of BNL's key stakeholders and the community, significant progress was made to advance cleanup projects in 2004. In March, cleanup of portions of the Peconic River, both on and off the site, began. Remediation plans include the removal, treatment, and disposal of sediment containing contaminants such as mercury and PCBs. The long-term plan includes habitat restoration and long-term monitoring of surface water, sediment, and fish. Also, in August, a draft plan for the cleanup of the Brookhaven Graphite Research Reactor (BGRR) was submitted to the community for comment.

These are just some of the highlights of the achievements and advances made within BNL's environmental management program in 2004. The Laboratory, with the help of our stakeholders and community, will continue to deliver on our commitment to environmental performance in 2005 and beyond.

A handwritten signature in black ink that reads "Praveen Chaudhari". The signature is written in a cursive, flowing style.

Praveen Chaudhari
Laboratory Director

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Executive Summary

Each year, Brookhaven National Laboratory (BNL) prepares an annual Site Environmental Report (SER) in accordance with DOE Order 231.1A, Environment, Safety and Health Reporting of the U.S. Department of Energy (DOE). The SER is written to inform the public, regulators, Laboratory employees, and other stakeholders of BNL's environmental performance during the calendar year in review. The report summarizes BNL's environmental data; environmental management performance; compliance with applicable DOE, federal, state, and local regulations; and 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.

The SER is intended to be a technical document. It is available in print and as a downloadable file on the BNL web page at <http://www.bnl.gov/esd/SER.htm>. A summary of the SER is also prepared each year to provide a general overview of the report, and is distributed with a CD version of the full report. The summary supports BNL's educational and community outreach program.

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 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.

Chapter 1 of this report discusses current and past research; facilities and operations; location, population, and economy; the geology, hydrology, and climate of the site; and a brief overview of BNL's natural and cultural resources.

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 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 an EMS is a Laboratory Environmental Stewardship Policy. In 2004, BNL incorporated the principles of this Laboratory-wide policy into a comprehensive Environmental, Safety, Security, and Health (ESSH) Policy as it works towards OHSAS 18001 certification. This policy makes clear BNL's commitments to environmental stewardship, the safety of its em-

employees, and the security of the site. Specific environmental commitments include compliance, pollution prevention, cleanup, 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> and is included in all training programs for new employees, guests, and contractors.

In 2004, BNL operations led to seven awards for environmental performance from diverse stakeholder groups. Also in 2004, BNL was accepted into the EPA Performance Track Program, which is EPA's "gold standard" for facility-based environmental performance—a standard that participating members strive to attain as they "meet or exceed their performance commitment."

The Laboratory's EMS was designed to meet the rigorous requirements of the globally recognized International Organization for Standardization (ISO) 14001 Environmental Management Standard. BNL was the first DOE Office of Science Laboratory to become officially registered to this standard. Annual independent 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 2004, an EMS recertification audit determined that BNL remains in full conformance with the standard. Audit findings included five minor nonconformances, three opportunities for improvement, and five examples of continual improvement.

A strong Pollution Prevention (P2) Program is an essential element of the successful completion 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 \$1.6 million and have resulted in the reduction or reuse of

approximately 2.3 million pounds of waste. In 2004, eight new pollution prevention proposals were funded, investing approximately \$86,000, with an anticipated annual savings from these projects of \$60,500, for an average payback period of 1.3 years.

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 exposures and evaluate the impacts BNL activities may be having on the environment. An overview of the Laboratory's environmental programs and a summary of performance for 2004 are discussed 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 groundwater remediation systems, and several other binding agreements. In 2004, BNL operated in full compliance with most of these requirements, and programs are in place to address areas for continued improvement. In February, the New York State Department of Environmental Conservation (NYSDEC) approved a modified testing process. The change allowed storm-water runoff samples to be filtered, to remove sediment containing naturally-present metals, primarily aluminum and iron. The modified State Pollutant Discharge Elimination System (SPDES) permit also postponed chronic toxicity testing of the Sewage Treatment Plant (STP) because five quarters of routine testing had shown no impact. Testing will resume in 2005.

Twelve external environmental audits by regulatory agencies were conducted in 2004,

including inspections of petroleum and chemical storage, air emissions from the Central Steam Facility (CSF), Hazardous Waste Management facilities, STP operations, other regulated outfalls and recharge basins, and the potable water system. Minor administrative deficiencies found during two Resource Conservation and Recovery Act (RCRA)/hazardous waste compliance inspections were corrected before the inspectors left the site. Four conditions that required corrective action were identified during an annual inspection of the Major Petroleum Facility (MPF) and one issue was found during an inspection of the Chemical Bulk Storage Facilities; all five of these conditions are being corrected in accordance with NYSDEC directives.

Compliance monitoring in 2004 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 MPF continued to demonstrate that current oil storage and transfer operations are not impacting groundwater quality; and, with the exception of six permit excursions at the STP, liquid effluents discharged to surface water and groundwater met all applicable SPDES permit requirements. The six SPDES excursions included: two for the detection of methylene chloride in the discharge, which was determined to be the result of analytical contract laboratory cross-contamination; two for the detection of iron in the discharge; one for average suspended solids concentration; and one for suspended solids removal. The latter four excursions were attributed to poor placement of a sample collection probe. Each of these issues was investigated and reported to NYSDEC and the Suffolk County Department of Health Services.

There were 30 reportable spills of petroleum products or antifreeze in 2004. All releases were cleaned up or addressed to the satisfaction of NYSDEC. Nineteen spills were petroleum releases less than 5 gallons, four were small-volume antifreeze spills, two larger spills were discovered during tank removals, four spills resulted from failed equipment, and one spill was a release of oil from two transformers that were contaminated with polychlorinated biphenyls.

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. During 2004, BNL facilities released a total of 2,711 curies of radioactive gases with short half-lives (less than 30 minutes). EPA regulations require continuous monitoring of all facilities that have the potential to deliver an annual radiation dose greater than 0.1 mrem to a member of the public. The Brookhaven Linac Isotope Producer (BLIP) is the only BNL facility in this category. Oxygen-15 (half-life: 122 seconds) and carbon-11 (half-life: 20.48 minutes) emitted from the BLIP constituted more than 99.8 percent of air emissions in 2004. Facilities capable of delivering radiation doses below 0.1 mrem require periodic, confirmatory monitoring. At BNL, this monitoring is conducted at one active facility, the Target Processing Laboratory, and two inactive facilities, the Brookhaven Medical Research Reactor (BMRR) and the High Flux Beam Reactor (HFBR). In 2004, BNL filed a petition with EPA to discontinue emission monitoring at the BMRR, because sampling has consistently shown no detectable emissions of radionuclides, even with building ventilation turned on.

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 this monitoring. Two of the four boilers at the CSF are equipped with continuous emission monitors to measure nitrogen oxides and opacity. In 2004, these boilers had no measured emission exceedances above the regulatory limits, for nitrogen oxides. Opacity exceedances were reported to NYSDEC; all but two occurred during boiler startup or soot blowing operations—times when opacity exceedances are most likely.

Since natural gas prices were higher than residual fuel prices throughout 2004, BNL used residual fuel for most heating and cooling. As a result, annual facility emissions of particulate matter, nitrogen oxides, and sulfur dioxide were

considerably higher than in years when natural gas was the primary fuel.

The Laboratory conducts ambient radiological air monitoring to verify local air quality and assess possible environmental and health impacts from BNL operations. Air monitoring stations around the perimeter of the BNL site measure tritium and gross alpha and beta airborne activity. Results measured at BNL in 2004 demonstrated that on-site radiological air quality was consistent with results from locations in New York State that are not located near radiological facilities.

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

Water Quality Surveillance Program

BNL discharges treated wastewater into the headwaters of the Peconic River via the STP, and 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 and that the public, employees, and the environment are protected.

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, located to the west of BNL, is monitored as a geographical control location for comparative purposes, as it is not affected by BNL operations. In 2004, the average gross alpha and beta activity levels of the STP discharge were within the typical range of historical levels and were well below drinking water standards. Tritium releases to the Peconic River fell below levels reported in 2002 and are expected to continue to decline, after a brief increase in 2003, following the preparatory steps for decommissioning and decontaminating the HFBR. There were no detections of cesium-137 (Cs-137) or strontium-90 (Sr-90) in the STP effluent. Traces of tritium were found, but in amounts below the minimum [measurable] detection limit. Nonradiological monitoring of the efflu-

ent showed that, with the exception of isolated incidents involving metals that occur naturally in local sediment, organic and inorganic parameters were within the SPDES effluent limitations or other applicable standards.

On-site 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 analyses in 2004 showed that the low levels of alpha and beta activity detected in all of the basins were not attributable to BNL operations but to natural terrestrial/geological or cosmic sources. A very low level of tritium, detected in a single sample, was attributed to inaccuracies of the analytical method. Nonradiological analyses showed low concentrations of volatile organic compounds (VOCs); when investigated, these were found to be due to cross-contamination of the samples at the analytical contract laboratory. Lead at the CSF outfall, attributed to accumulating sediment, continued to be monitored in 2004. The completed remedial plan previously in place was revised and resubmitted to the regulatory agencies in March. Their review is pending.

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 BNL's scientific mission. The goals of the program include protecting and monitoring the ecosystem, conducting research, and communicating with the public, stakeholders, and staff members regarding environmental issues. Precautions are taken to protect and enhance habitats and natural resources at the Laboratory. 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 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 other wildlife populations, such as wild turkey and white-tailed deer, to ensure that they are sustained. In 2004, an infrared aerial survey indicated a much lower deer population than had been estimated using ground-based survey methods, which was subsequently reviewed and refined. The wild turkey population on site continues to grow; in March, the NYSDEC relocated 29 turkeys from BNL to the Easthampton area.

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 2004, deer and fish 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 from the BNL boundary 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. Although hunting is restricted on site, the New York State Department of Health has reviewed the potential public health risk associated with elevated Cs-137 levels in on-site deer and determined that formal health advisories are warranted. On- and off-site sampling of fish found low levels of Cs-137, pesticides, and mercury. With completion of the Peconic River cleanup project, these levels are expected to drop.

Precipitation samples were collected quarterly at two air monitoring stations and analyzed for radiological content. Samples collected in 2004 showed gross alpha measurements at both stations above the minimum detection limit, although the values are within the range of those historically reported.

The Upton Ecological and Research Reserve (Reserve) was established on site by DOE. The 530-acre Reserve, managed by the U.S. Fish & Wildlife Service (FWS), is used to conduct resource management programs for the conser-

vation, enhancement, and restoration of wildlife and habitat. Completing the fourth year of managing the reserve, its technical advisory group approved funding for research projects that included the development of a research database, forest health monitoring protocols, mapping of vernal pools, educational and outreach activities, researcher access and training requirements, and conducting radio telemetry work on the eastern hognose snake and spotted turtle. Also in 2004, the Reserve conducted its first prescribed fire, treating approximately seven acres to improve germination and recruitment of oak seedlings. The fire also reduced fine-textured forest fuels that tend to increase the severity of wildfires. Post-fire monitoring will be conducted to determine whether the prescribed fire had the expected beneficial effects.

The goal of BNL's Cultural Resource Management Program (CRMP) is to ensure the proper stewardship of BNL and DOE historic resources. Additional goals include maintaining compliance with various historic preservation and archeological laws and regulations, and ensuring the availability of resources to 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 be used to guide the management of all of the Laboratory's cultural resources. In 2004, two archeological projects were completed, including the survey and evaluation of the architectural significance of Berkner Hall and the Chemistry Building. The evaluation concluded that both buildings appear to be eligible for listing on the National Register of Historic Places. In addition, an archeological evaluation of two sites at BNL believed to date to the 1800s was performed; both sites may be eligible for listing on the National Register of Historic Places. Another goal of the CRMP is to formalize an oral history of the Laboratory. Four video interviews with long-time employees and three individuals associated with the early development and construction of the National Synchrotron Light Source were conducted.

Chapter 6 of this report describes BNL's Natural and Cultural Resource Management Programs 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 entering and leaving the BNL site. In 2004, BNL collected groundwater samples from 828 on-site and off-site monitoring wells during 2,207 individual sampling events. BNL has not detected any new impacts to groundwater quality since 2001.

Under the environmental surveillance program, 125 wells at ten active research and support facilities were monitored during 318 individual sampling events. Although no new impacts to groundwater quality were discovered in 2004, groundwater quality continues to be impacted from older releases at four facilities. Tritium continues to be detected at concentrations above the drinking water standard in wells immediately downgradient of the g-2/VQ-12 source area in the Alternating Gradient Synchrotron facility, and in one well immediately downgradient of the BLIP. However, the tritium concentrations are much lower than those observed in 2003. Monitoring data suggest that the continued release of tritium from these source areas is due to residual tritium being flushed out of the lower unsaturated zone close to the water table by natural water table fluctuations. As in previous years, VOCs associated with historical petroleum and solvent spills were detected in several monitoring wells directly downgradient of the Motor Pool and Service Station area, but at concentrations that were generally lower than those observed in 2003.

Under the Environmental Restoration program, 703 on-site and off-site wells were monitored during 1,889 individual sampling events. Monitoring data indicate that the restoration activities are effectively capturing and treating groundwater contamination. The construction of groundwater treatment systems was completed in 2004 with a total of 16 systems now complete. In the former Building 96

area, significant reductions in VOC concentrations allowed three of four treatment wells to be shut down and placed in standby mode in July 2004. In December 2004, BNL began to treat the remaining high levels of VOCs in the former Building 96 "silt zone" source area using an in situ method of chemical oxidation. The operation of the Operable Unit (OU) III Carbon Tetrachloride Treatment System has also significantly reduced VOC levels in groundwater near a former underground storage tank source area. As a result, the treatment system was shut down and placed in standby mode in August 2004. Construction of a Sr-90 groundwater treatment system for the Brookhaven Graphite Research Reactor and Waste Control Facility area was completed in December 2004, and startup testing will begin in January 2005. High levels of tritium were periodically detected in groundwater immediately downgradient of the HFBR during 2004. The continued release of tritium appears to be due to residual tritium that is being flushed out of the lower unsaturated zone by natural water table fluctuations.

During 2004, 12 groundwater remediation systems removed 652 pounds of VOCs, and one system removed approximately 0.4 mCi of Sr-90. The systems returned approximately 1.5 billion gallons of treated water to the Upper Glacial aquifer. Since the beginning of active groundwater remediation activities in December 1996, BNL has removed 4,808 pounds of VOCs and 1.3 mCi of Sr-90 by treating nearly 8.4 billion gallons of groundwater.

Chapter 7 of this report provides an overview of the Groundwater Protection Management Program, and the SER Volume II, *Groundwater Status Report*, provides a detailed description, data, and maps relating to all groundwater monitoring.

Radiological Dose Assessment Program

BNL routinely assesses its operations to ensure that any potential radiological dose to members of the public, BNL workers, and the environment is "As Low As Reasonably Achievable" (ALARA). The potential radiological dose is calculated as the largest possi-

ble 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 BNL have consistently shown that the “effective dose equivalent” from BNL 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 2004 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 on the BNL site and in the surrounding communities. In 2004, the average doses from 56 on-site and 16 off-site TLDs showed there was no additional contribution to dose from BNL operations above natural background radiation. The annual on-site external dose from all potential sources, including cosmic and terrestrial radiation, was 66 ± 11 mrem, whereas the annual off-site external dose was 62 ± 10 mrem.

The effective dose to the MEI from air emissions was calculated as $4.40\text{E-}2$ mrem (0.44 μSv). The ingestion pathway dose was estimated as 1.31 mrem (13.1 μSv) from consumption of deer meat and 0.37 mrem (3.7 μSv) from consumption of fish caught on site. The total annual dose to the MEI from all pathways was estimated as 1.72 mrem (17.2 μSv). The BNL dose from the air inhalation pathway was 0.4 percent of EPA’s annual regulatory dose limit of 10 mrem (100 μSv), and less than 2 percent of DOE’s annual dose limit of 100 mrem ($1,000$ μSv) from all pathways. Doses to aquatic and terrestrial biota were also evaluated and found to be well below the regulatory limits.

Remediation and waste management projects conducted in 2004 were evaluated for radiological emissions and dose impact. There were no significant dose or radiological risks to the public, BNL workers, or the environment from these activities.

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 contract 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 they are used to support decision making.

In 2004, BNL used the on-site Analytical Services Laboratory (ASL) and five off-site analytical contract 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 (PE) testing, review of QA programs, and audits. The ASL ceased performing analyses in January of 2004. For the remainder of the year, all samples were sent to off-site analytical contract laboratories.

Four of the analytical contract laboratories participated in several national and state PE testing programs in 2004. Results of the tests provide information on the quality of a laboratory’s analytical capabilities. The analytical contract laboratories performing radiological analyses had “average overall satisfactory” scores (as defined by the independent testing organizations) of 96 and 87 percent, respectively. The overall satisfactory scores for non-radiological testing ranged from 94.2 to 97.9 percent. The analytical contract laboratories received an “acceptable” rating for a combined average overall satisfactory score of 93.9 percent on the radiological and nonradiological PE tests performed.

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

2004 Site Environmental Report Team

The SER Team realizes that many other employees contributed to this report and thanks everyone for their assistance.

The SER Team

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A Note from the Editor

Throughout the Site Environmental Report, there are many references to Brookhaven National Laboratory (BNL), the U.S. Department of Energy (DOE), and the U.S. Environmental Protection Agency (EPA). These acronyms, and others that are explained in each chapter, are used interchangeably with their spelled-out forms as an aid to readers. Also, Appendix A opens with a list of acronyms and their meanings.

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Introduction

Established in 1947, Brookhaven National Laboratory (BNL) is a multi-program national laboratory operated by Brookhaven Science Associates (BSA) for the U.S. Department of Energy (DOE). BSA, a nonprofit, limited-liability company founded in 1997 by Stony Brook University and Battelle Memorial Institute, has been managing and operating the Laboratory under a performance-based contract with DOE since 1998. From 1947 to 1998, BNL was operated by Associated Universities Incorporated. Prior to 1947, the site operated as Camp Upton, a U.S. Army training camp, which was active from 1917 to 1920 during World War I and from 1940 to 1946 during World War II.

BNL has a long, distinguished history as one of the top research laboratories in the world. For over 50 years, BNL researchers have successfully worked to visualize, construct, and operate large and unique scientific facilities and use the data generated to make advances in many fields. Under BSA's management, new programs in place at BNL emphasize improved environmental, safety, and health performance, including pollution prevention and waste minimization.

I.1 LABORATORY MISSION

BNL's broad mission is to produce world-class science in a safe and environmentally sound manner with the cooperation, support, and appropriate involvement of its scientific and local communities. The Laboratory supports DOE's strategic missions of carrying out basic and applied research in long-term programs. The Laboratory plays a lead role in the DOE Science and Technology mission and contributes to the DOE missions in Energy Resources, Environmental Quality, and National Security. The fundamental elements of BNL's role in support of these key DOE missions are:

- To conceive, design, construct, and operate complex, leading-edge, user-oriented research facilities.
- To develop advanced technologies that address national needs and initiate their transfer to other organizations and to the commercial sector.
- To disseminate technical knowledge to educate future generations of scientists and engineers.
- To maintain technical currency in the

nation's workforce and encourage scientific awareness in the general public.

BNL's Environmental, Safety, Security, and Health (ESSH) Policy is the Laboratory's commitment to continual improvement in ESSH performance and is consistent with the Laboratory's research interests, ethics, and shared values. Environmental commitments in the policy include compliance, pollution prevention, cleanup, community outreach, and continual improvement. The complete policy can be found at <http://www.bnl.gov/eshq/ESSH.asp>.

I.2 RESEARCH AND DISCOVERIES

Primarily funded by DOE, BNL conducts applied research in nuclear and high-energy physics, chemistry and physics of materials, environmental and energy research, nonproliferation, neurosciences and medical imaging, and structural biology. Approximately 2,700 scientists, engineers, technicians, and support staff work at BNL, and more than 4,000 guest researchers from all over the world visit the site each year to participate in scientific collaborations. BNL also designs, builds, and operates

major world-class research facilities that are available to university, industrial, and government personnel. In addition to BNL's current facilities, construction of a Center for Functional Nanomaterials (CFN) is planned to start in the spring of 2005, with building occupancy and technical equipment installation to begin in early 2007. One of five nanotechnology centers approved by DOE, it will provide researchers with state-of-the-art capabilities to fabricate and study nanoscale materials. The possible benefits of nanoscience include faster computers, improved solar energy conversion, stronger and lighter materials, improved chemical and biological sensing, efficient and rapid detection and remediation of pollutants and pathogens in the environment, more efficient catalysts to speed chemical processes, molecular motors, and new drugs.

To date, six Nobel Prizes, including the 2002 Nobel Prize in Physics and the 2003 Nobel Prize in Chemistry, have been awarded for discoveries made at BNL. Examples of current research being conducted at the Laboratory include pollution mitigating bacteria; structural studies of the Lyme disease protein for new vaccines; studies of the brain, including the roots of drug addiction, psychiatric disorders, and metabolism; asbestos-digesting foam; the invention of the quiet jackhammer, which won a 2000 Discover Award; promising cocaine addiction treatments; large-scale studies of the effect of increased carbon dioxide on ecosystems; cleaner, more efficient oil burners; testing of the impacts of space radiation on spacecraft parts; the investigation of the basic building blocks of matter; and testing the Standard Model of physics, a theory which attempts to explain the forces of nature such as gravity. Some important discoveries made at BNL include L-dopa, used to treat Parkinson's disease; Magnetically-levitated (maglev) trains; the use of x-rays and neutrons to study biological specimens; the radionuclide thallium-201, used in heart stress tests; the radionuclide technetium-99, used to diagnose heart disease; x-ray angiography for noninvasive heart imaging; and pioneering solar neutrino studies seeking the answer to the mystery of the "missing neutrinos from our solar system's sun, and neutrino bursts from supernovae." Further information regarding

research and discoveries at BNL can be found at <http://www.bnl.gov>.

1.3 FACILITIES AND OPERATIONS

Most of BNL's principal facilities are located near the center of the site. The developed area is approximately 1,650 acres:

- 500 acres originally developed by the Army (as part of Camp Upton) and still used for offices and other operational buildings
- 200 acres occupied by large, specialized research facilities
- 550 acres used for outlying facilities, such as the Sewage Treatment Plant, research agricultural fields, housing facilities, and fire breaks
- 400 acres of roads, parking lots, and connecting areas

The balance of the site, approximately 3,600 acres, is mostly wooded and represents the native Pine Barrens ecosystem.

The major scientific facilities at BNL are briefly described in Figure 1-1. The three former research reactors, no longer operational, are discussed in Section 1.4. Additional facilities, shown in Figure 1-2 and briefly described below, support BNL's science and technology mission by providing basic utility and environmental services.

- *Central Chilled Water Plant.* This facility provides chilled water sitewide for air conditioning and process refrigeration via underground piping. The plant has a large refrigeration capacity and reduces the need for local refrigeration plants and air conditioning.
- *Central Steam Facility (CSF).* This plant provides high-pressure steam for facility and process heating sitewide. Either natural gas or fuel oil can be used to produce the steam, which is conveyed to other facilities through underground piping. Condensate is collected and returned to the CSF for reuse, to conserve water and energy.
- *Fire Station.* The Fire Station houses six response vehicles. The BNL Fire Rescue Group provides on-site fire suppression, emergency medical services, hazardous material response, salvage, and property

protection. The fire rescue group responds within 5 minutes to any emergency in the core area of the Laboratory and within 8 minutes to emergencies in the outer areas (RHIC and eastern portions of the site).

- *Major Petroleum Facility (MPF)*. This facility provides reserve fuel for the CSF during times of peak operation. With a total capacity of 2.3 million gallons, the MPF primarily stores No. 6 fuel oil. The 1997 conversion of the CSF boilers to burn natural gas as well as oil has significantly reduced BNL's reliance on oil as a fuel source and reduced emissions.
- *Sewage Treatment Plant (STP)*. This facility treats sanitary and certain process wastewater from BNL facilities prior to discharge into the Peconic River, similar to the operations of a municipal sewage treatment plant. The plant has a design capacity of 3 million gallons per day. Effluent is monitored and controlled under a permit issued by the New York State Department of Environmental Conservation (NYSDEC).
- *Waste Concentration Facility (WCF)*. This facility was previously used for the receipt, processing, and volume reduction of aqueous radioactive waste. At present, the WCF houses equipment and auxiliary systems required for operation of the Liquid Low-Level Radioactive Waste pump systems.
- *Waste Management Facility (WMF)*. This facility is a state-of-the-art complex for managing the wastes generated from BNL's research and operation activities. The facility was built with advanced environmental protection systems and features, and began operation in December 1997.
- *Water Treatment Plant (WTP)*. The potable water treatment facility has a capacity of 5 million gallons per day. Potable water is obtained from six on-site wells. Three wells located along the western boundary of the site are treated with a lime softening process to remove naturally occurring iron. The plant is also equipped with dual air-stripping towers to ensure that volatile organic compounds (VOCs) are at or below New York State drinking water standards. Three

wells located along the eastern section of the developed site are treated with carbon to ensure that VOC levels meet the drinking water standards. BNL's water met all drinking water standards in 2004.

1.4 HISTORY

BNL was founded in 1947 by the Atomic Energy Commission. The objective was to build a regional laboratory that could provide researchers with powerful tools too costly for their home institutions to build and maintain. Although BNL no longer operates any research reactors, the Laboratory's first major scientific facility was the Brookhaven Graphite Research Reactor (BGRR), which operated from 1950 to 1968 and is now being decommissioned. The BGRR was used for peaceful scientific exploration in the fields of medicine, biology, chemistry, physics, and nuclear engineering. The BGRR's capacity was replaced and surpassed in 1965 by the High Flux Beam Reactor (HFBR), which provided neutrons for researchers in diverse subjects ranging from solid state physics to art history. For more than 30 years, the HFBR was one of the premier neutron beam reactors in the world. During a scheduled maintenance shutdown in 1997, workers discovered a leak in the HFBR's spent fuel storage pool. In November 1999, the Secretary of Energy decided that the HFBR would be permanently closed and decommissioned. All spent fuel from the HFBR has been removed and transported off site for disposal.

Medical research at BNL began in 1950 with the opening of one of the first hospitals devoted to nuclear medicine. It was followed by the Medical Research Center in 1958, the Brookhaven Medical Research Reactor (BMRR) in 1959, and the Brookhaven Linac Isotope Producer (BLIP) in 1973. The BNL Center for Imaging and Neuroscience was established in 1996 and includes the Positron Emission Tomography (PET) and magnetic resonance imaging (MRI) equipment. The development of these powerful imaging methods has given scientists a unique opportunity to reveal the molecular mechanisms of human disease and to facilitate the development of new drugs for

Figure I-1. Major Scientific Facilities at BNL.

1. Relativistic Heavy Ion Collider (RHIC)

The RHIC is a world-class scientific research facility. The RHIC accelerator drives two intersecting beams of gold ions, other heavy metal ions, and protons head-on to form subatomic collisions. What physicists learn from these collisions may help us understand more about why the physical world works the way it does, from the smallest subatomic particles, to the largest stars. Current RHIC experiments include the Solenoidal Tracker at RHIC (STAR), a detector used to track particles produced by ion collisions; the PHENIX detector, used to record different particles emerging from collisions; the Broad Range Hadron Magnetic Spectrometer (BRAHMS), used to study particles as they pass through detectors; and PHOBOS, an experiment based on the premise that when new collisions occur, new physics will be readily identified.

2. Alternating Gradient Synchrotron (AGS)

The AGS is a particle accelerator used to propel protons and heavy ions to high energies for physics research. The AGS is capable of accelerating protons and heavy ions, such as gold and iron. The Linear Accelerator (Linac) serves as a proton injector for the AGS Booster.

3. AGS Booster

The AGS Booster is a circular accelerator used for physics research and radiobiology studies. It receives either a proton beam from the Linac or heavy ions from the Tandem Van de Graaff and accelerates these before injecting them into the AGS ring for further acceleration. The Booster will also serve as the energetic heavy ion source for the NASA Space Radiation Laboratory. Construction is planned for spring 2005. This new facility will be used to simulate the harsh cosmic and solar radiation environment found in space.

4. Linear Accelerator (Linac) and Brookhaven Linac Isotope Producer (BLIP)

The Linac provides beams of polarized protons for the AGS and RHIC. The excess beam capacity is used to produce radioisotopes for research and medical imaging at the BLIP. The BLIP is one of the nation's key production facilities for radioisotopes, which are crucial to clinical nuclear medicine. The BLIP also supports research on new diagnostic and therapeutic radiopharmaceuticals.

5. Heavy Ion Transfer Line (HITL)

The HITL connects the Tandem Van de Graaff and the AGS Booster. This interconnection enables the transport of ions of intermediate mass to the AGS Booster, where they are accelerated before injection into the AGS. The ions are then extracted and sent to the AGS experimental area for physics research.

6. Radiation Therapy Facility (RTF)

Part of the Medical Research Center, the RTF is a high energy dual x-ray mode linear accelerator used for radiation therapy for cancer patients. This accelerator delivers therapeutically useful beams of x-rays and electrons for conventional

and advanced medical radiotherapy techniques.

7. Brookhaven Medical Research Reactor (BMRR)

The BMRR was the world's first nuclear reactor built exclusively for medical research and therapy. It produced neutrons in an optimal energy range for experimental treatment of a type of brain cancer known as glioblastoma multiforme. The BMRR was shut down in December 2000 due to a reduction in medical research funding.

8. Scanning Transmission Electron Microscope (STEM)

The STEM facility includes two microscopes, STEM 1 and STEM 3, used for biological research. Both devices allow scientists to see the intricate details of living things, from bacteria to human tissue. The images provide a picture and data that are used in Mass Analysis.

9. National Synchrotron Light Source (NSLS)

The NSLS uses a linear accelerator and booster synchrotron as an injection system for two electron storage rings that provide intense light spanning the electromagnetic spectrum from the infrared through x-rays. The properties of this light and the 80 specially designed experimental stations, called beamlines, allow scientists to perform a large variety of experiments.

10. High Flux Beam Reactor (HFBR)

The HFBR was one of the premier neutron physics research facilities in the world. Neutron beams produced at the HFBR were used to investigate the molecular structure of materials, which aided in pharmaceutical design and materials development and expanded the knowledge base of physics, chemistry, and biology. The HFBR was permanently shut down in November 1999.

11. Tandem Van de Graaff and Cyclotron

These accelerators are used in medium energy physics investigations and for producing special nuclides. The Tandem Van de Graff accelerators are used to bombard materials with ions for manufacturing and testing purposes, and to supply RHIC with heavy ions. The cyclotrons, operated by the Chemistry Department, are used for the production of radiotracers for use in Positron Emission Tomography (PET) and Magnetic Resonance Imaging (MRI) studies.

12. Brookhaven Graphite Research Reactor (BGRR)

The BGRR was the first peace-time reactor to be constructed in the United States following World War II. It was used for scientific exploration in the fields of medicine, biology, chemistry, physics, and nuclear engineering. The BGRR is currently being decommissioned under the Environmental Restoration Program.

Figure I-2. Major Laboratory Support and Service Facilities at BNL.

doctors worldwide to treat patients and perform medical research. BNL's establishment of the Center for Translational Neuroimaging (CTN) bridges the gap between the microscopic cellular world and human behavior by using a network of complementary brain-imaging tools, including PET and MRI. The Laboratory also has an active outpatient Radiation Treatment Facility (RTF) operated by Stony Brook University where patients receive radiation treatments for a wide variety of cancers. Except for the BMRR, all of the medical facilities

are currently operating. Due to a reduction of research funding, the BMRR was shut down in December 2000. All spent fuel from the BMRR has been removed and transported off site for disposal.

High-energy particle physics research at BNL began in 1952 with the Cosmotron, the first particle accelerator to achieve billion-electron-volt energies. Work at the Cosmotron resulted in a Noble Prize in 1957. The Alternating Gradient Synchrotron (AGS), a much larger particle accelerator that surpassed the Cosmotron's capa-

bilities, became operational in 1960. The AGS has yielded many discoveries of new particles and phenomena, for which BNL researchers were awarded three Nobel Prizes in Physics in 1976, 1980, and 1988. The AGS Booster, constructed in 1991, further enhanced the capabilities of the AGS, enabling it to accelerate protons and heavy ions to even higher energies. The Tandem Van de Graaff accelerator began operating in 1970 and is the starting point of the chain of accelerators that provide ions of gold, other heavy metal ions, and protons for experiments at the Relativistic Heavy Ion Collider (RHIC).

Following 10 years of development and construction, RHIC, a two-ringed particle accelerator that drives two intersecting beams of gold ions, other heavy metal ions, or protons head-on in subatomic collisions, began operation in 2000. RHIC is used to study what the universe may have looked like in the first few moments after its creation. Physicists hope to understand more about why the physical world works the way it does, from the smallest subatomic particles as they existed in their earliest forms.

In 1984, researchers began using the National Synchrotron Light Source (NSLS), which uses a linear accelerator and booster synchrotron to guide charged particles in orbit inside electron storage rings for use in a wide range of physical and biological experiments. A proposal is in place for the construction of NSLS-II, a state-of-the-art energy storage ring that will produce x-rays up to 10,000 times brighter than those produced at the NSLS today.

Due to past operations and waste management practices at the Laboratory, BNL was added to the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) National Priorities List of contaminated sites in 1989. One of 27 such sites on Long Island identified for priority cleanup, BNL has made significant progress toward improving environmental operations and remediating past contamination.

1.5 LOCATION, LOCAL POPULATION, AND LOCAL ECONOMY

BNL is located on Long Island, 60 miles east of New York City. The Laboratory's 5,265-acre

site is near Long Island's geographic center and is part of the Town of Brookhaven, the largest township (both in area and population) in Suffolk County. Approximately 150 people live in apartments on site, and many of the scientists and students who visit BNL each year stay in the Laboratory's dormitories. More than 75 percent of BNL's employees live in Suffolk County.

BNL is one of the five largest high-tech employers on Long Island. With an annual budget of approximately \$454 million, the Laboratory has a major, positive economic impact on Long Island and New York State. An independent Suffolk County Planning Commission concluded that BNL's spending for operations, procurement, payroll, construction, medical benefits, and technology transfer spreads throughout Long Island's economy, making BNL vital to the local economic health (Kamer 1995).

In 2004, BNL purchased \$26.7 million worth of supplies and services from Long Island businesses. In addition to buying goods and services from Long Island vendors, Laboratory employees do most of their shopping locally. Employee salaries, wages, and fringe benefits account for almost 61 percent, or about \$279 million, of the Laboratory's total annual budget. BNL's total procurement budget in 2004 was approximately \$160 million. Out of that amount, approximately \$22.4 million was spent on 3,000 purchases in Suffolk County and approximately \$4.3 million toward 507 purchases made in Nassau County.

1.6 GEOLOGY AND HYDROLOGY

BNL is situated on the western rim of the shallow Peconic River watershed. The marshy areas in the northern and eastern sections of the site are part of the headwaters of the Peconic River. Depending on the height of the water table relative to the base of the riverbed, the Peconic River both recharges to, and receives water from, the sole source aquifer system beneath Long Island. In times of sustained drought, the river water typically recharges to the groundwater; with normal to above-normal precipitation, the river receives water from the aquifer.

In general, the terrain of the BNL site is gently rolling, with elevations varying between 44 and 120 feet above mean sea level. Depth to groundwater from the land surface ranges from 5 feet near the Peconic River to about 80 feet in the higher elevations of the central and western portions of the site. The hydrology of the local area is well defined. Studies of Long Island hydrology and geology in the vicinity of the Laboratory indicate that the uppermost Pleistocene deposits, composed of highly permeable glacial sands and gravel, are between 120 and 250 feet thick (Warren et al. 1968, Scorca et al. 1999). Water penetrates these deposits readily and there is little direct runoff into surface streams unless precipitation is intense. These sandy deposits store large quantities of water in the Upper Glacial aquifer. On average, about half of the annual precipitation is lost to the atmosphere through evapotranspiration and the other half percolates through the soil to recharge the groundwater (Koppelman 1978).

The Long Island Regional Planning Board and Suffolk County have identified the BNL site as overlying a deep-flow recharge zone for Long Island groundwater (Koppelman 1978, Suffolk County Department of Health Services 1987). Precipitation and surface water that recharge within this zone have the potential to replenish the deep Magothy and Lloyd aquifer systems lying below the Upper Glacial aquifer. Experts estimate that up to two-fifths of the recharge from rainfall moves into the deeper aquifers. The extent to which groundwater on site contributes to deep flow recharge has been confirmed through the use of an extensive network of shallow and deep wells installed at BNL and surrounding areas (Geraghty and Miller 1996). This groundwater system is the primary source of drinking water for both on- and off-site private and public supply wells and has been designated a sole source aquifer system by the Environmental Protection Agency (EPA).

During 2004, BNL used approximately 1.4 million gallons of groundwater per day to meet potable water needs and heating and cooling requirements. Approximately 75 percent of the water pumped from BNL supply wells is returned to the aquifer through on-site recharge

basins and permitted discharges to the Peconic River. Under normal hydrologic conditions, most of the water discharged to the river recharges to the Upper Glacial aquifer before leaving the BNL site. Human consumption, evaporation (cooling tower and wind losses), and sewer line losses account for the remaining 25 percent. An additional 4.1 million gallons of groundwater are pumped each day from remediation wells for treatment and then returned to the aquifer by way of recharge basins.

Groundwater flow direction across the BNL site is influenced by natural drainage systems flowing eastward along the Peconic River, southeast toward the Forge River, and south toward the Carmans River (Figure 1-3). Pumping from on-site supply wells affects the direction and speed of groundwater flow, especially in the central, developed areas of the site. The main groundwater divide on Long Island is aligned generally east–west and lies approximately one-half mile north of BNL. Groundwater north of the divide flows northward and ultimately discharges to the Long Island Sound. Groundwater south of the divide flows east and south, discharging to the Peconic River, Peconic Bay, south shore streams, the Great South Bay, and the Atlantic Ocean. The regional groundwater flow system is discussed in greater detail in *Stratigraphy and Hydrologic Conditions* (Scorca et al. 1999). In most areas at BNL, the horizontal velocity of groundwater is approximately 0.75 to 1.2 feet per day (Geraghty and Miller 1996). In general, this means that groundwater travels for approximately 20 to 22 years as it moves from the central, developed area of the site to the BNL southern boundary.

1.7 CLIMATE

The Meteorological Group at BNL has been recording weather data on site since 1948. BNL is broadly influenced by continental and maritime weather systems. Locally, the Long Island Sound, the Atlantic Ocean, and associated bays influence wind directions and humidity and provide a moderating influence on extreme summer and winter temperatures. The prevailing ground-level winds at BNL are from the southwest during the summer, from the north-

Explanation: The arrows formed by the wedges indicate wind direction. Each concentric circle represents a 5 percent frequency, that is, how often the wind came from that direction. The wind direction was measured at heights of 10 and 90 meters. This diagram indicates that the predominant wind direction was from the south at the 10-m level and south-southwest at the 90-m level.

Figure 1-4. BNL 2004 Wind Rose.

west during the winter, and about equally from these two directions during the spring and fall (Nagle 1975, 1978). Figure 1-4 shows the 2004 annual wind rose for BNL, which depicts the annual frequency distribution of wind speed and direction, measured at an on-site meteorological tower at heights of 33 feet (10 meters) and 300 feet (90 meters).

Total snowfall in 2004 was 60.2 inches, well above the annual average of 30.4 inches. Total precipitation for 2004 was 35.86 inches, mak-

ing 2004 the third driest year on record at BNL. The average yearly precipitation is 48.5 inches. Figures 1-5 and 1-6 show the 2004 monthly and the 56-year annual precipitation data. The average yearly temperature for 2004 was 51.3°F. July was the hottest month with an average temperature of 71.8°F and January was the coldest month with an average temperature of 23.6°F. Figures 1-7 and 1-8 show the 2004 temperatures and the historical annual mean temperatures.

1.8 NATURAL RESOURCES

BNL is located in the oak/chestnut forest region of the Coastal Plain and constitutes about 5 percent of the 100,000-acre New York State-designated region on Long Island known as the Central Pine Barrens. The section of the Peconic River running through BNL is designated Scenic by the New York State Wild, Scenic, and Recreational River System Act of 1972. Due to the general topography and porous soil, the land is very well drained and there is relatively little surface runoff or open standing water. However, depressions form small, pocket wetlands with standing water on a seasonal basis (vernal pools), and there are six significant, regulated wetlands on site. Thus, a mosaic of wet and dry areas correlates with variations in topography and depth to the water table.

Vegetation on site is in various stages of succession, which reflects a history of disturbances to the area. For example, when Camp Upton was constructed in 1917, the site was entirely cleared of its native pines and oaks. Portions were then cleared again in 1940 when Camp Upton was reactivated. Other past disturbances include fire, local flooding, and draining. Current operations minimize disturbances to the more natural areas of the site.

More than 230 plant species have been identified at BNL, including one New York State threatened species and two that are rare. Fifteen animal species identified on site include a number that are protected in New York State, as well as species common to mixed hardwood forests and open grassland habitats. At least 85 species of birds have been observed nesting on site, and more than 200 transitory bird species have been documented as visiting the

Figure I-5. BNL 2004 Monthly Precipitation versus 56-Year Monthly Average.

Figure I-6. BNL Annual Precipitation Trend (56-Year).

site as a result of BNL's location within the Atlantic Flyway, and the scrub/shrub habitats that offer food and rest to migratory songbirds. Permanently flooded retention basins and other watercourses support amphibians and aquatic reptiles. Thirteen amphibian and 12 reptile species have been identified at BNL. Recent ecological studies have confirmed 22 breeding sites for the New York State endangered eastern

tiger salamander in ponds and recharge basins on site. Ten species of fish have been identified as endemic to the site, including the banded sunfish and the swamp darter, both of which are New York State threatened species. Two types of butterflies that are protected in New York are believed to breed on site due to preferred habitat and host plants. In 2004, the worm snake, a species of special concern, was identified on

Figure I-7. BNL 2004 Monthly Mean Temperature versus 56-Year Monthly Average.

Figure I-8. BNL Annual Mean Temperature Trend (56-Year).

site. To eliminate or minimize any negative effects that Laboratory operations might cause to these species, precautions are in place to protect the on-site habitat and natural resources.

In November 2000, DOE established the Upton Ecological and Research Reserve at BNL. The 530-acre Reserve (10 percent of the Laboratory's property) is on the eastern portion

of the site, in the Core Preservation Area of the Pine Barrens. The Upton Reserve creates a unique ecosystem of forests and wetlands that provide habitats for plants, mammals, birds, reptiles, and amphibians. Under an Inter-Agency Agreement with DOE, the U.S. Fish & Wildlife Services (FWS) conducts resource management programs for the conservation,

enhancement, and restoration of wildlife and habitat in the Reserve. The Upton Reserve Technical Advisory Group, made up of local land management agencies, assists BNL and FWS with technical expertise and helps determine policy for the Upton Reserve. Additional information regarding the Upton Reserve and BNL's natural resources can be found in Chapter 6 of this report and at <http://www.bnl.gov/esd/wildlife/Home.htm>.

1.9 CULTURAL RESOURCES

The Laboratory is responsible for ensuring compliance with historic preservation requirements. A cultural resource management plan is being developed to guide the management of all of BNL's cultural resources. These resources include World War I trenches, Civilian Conservation Corps features, World War II buildings, and historic structures, programs, and discoveries associated with high energy physics, research reactors, and other science. BNL currently has three facilities that have been determined as eligible for listing on the National Register of Historic Places. These historical facilities include the Brookhaven Graphite Research Reactor complex, the High Flux Beam Reactor complex, and the World War I training trenches associated with Camp

Upton. Further information and current projects can be found in Chapter 6, Section 6.9.

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Environmental Management System

One of Brookhaven National Laboratory's highest priorities is ensuring that the Laboratory's environmental performance measures up to its world-class status in science. Brookhaven Science Associates (BSA), the contractor operating the Laboratory on behalf of DOE, takes environmental stewardship very seriously. As part of BSA's commitment to environmentally responsible operations, they have established the BNL Environmental Management System (EMS). One measure of an effective EMS is recognition of good environmental performance. In 2004, BNL operations led to seven awards from a diverse stakeholder group, as follows.

- *EPA Environmental Quality Award for developing and managing the Upton Ecological and Research Reserve, a 530-acre conservation area on the BNL site.*
- *DOE Office of Science Best in Class Award, DOE Pollution Prevention Award, and White House Closing the Circle Award in recognition of leadership and management in developing and integrating BNL's EMS into its operational and business systems.*
- *DOE Office of Science Pollution Prevention Accomplishment Award for implementing an innovative process, Mixed Waste Elimination through Process Modification.*
- *Long Island Pine Barrens Society award for "Outstanding Contribution to Long Island's Environment" for BNL's comprehensive cleanup of contamination within the Pine Barrens on site, and for BNL programs of research, education, and community involvement.*
- *Evelyn Liblit Environmental Stewardship Award for BNL's commitment to environmental protection and its very successful and longstanding recycling program. The award was presented by the Waste Reduction and Management Institute of Stony Brook University.*

In addition, BNL was accepted into EPA's prestigious Performance Track Program, which is discussed in Section 2.3.4.9.

An EMS ensures that environmental issues are systematically identified, controlled, and monitored. Moreover, an EMS provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual 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.

Annual audits are required to maintain EMS registration. Recertification audits of the entire EMS occur every 3 years. In 2004, an EMS Recertification Audit determined that BNL remains in conformance with the ISO 14001 Standard.

The Laboratory continued its strong support of the Pollution Prevention Program in 2004. This program seeks ways to eliminate waste and toxic materials and is the preferred approach to resolving environmental issues at BNL. In 2004, pollution prevention projects had saved more than \$1.6 million and resulted in the reduction or reuse of approximately 2.2 million pounds of waste. Also in 2004, the BNL Pollution Prevention Council funded eight new proposals, investing approximately \$86,000. Anticipated annual savings from the projects are estimated at \$60,500, for an average payback period of 1.3 years. The ISO 14001-registered EMS and the nationally recognized Pollution Prevention Program continue to contribute to BNL's success in promoting pollution prevention.

BNL also continues to address legacy issues under the Environmental Restoration Program and is openly communicating with neighbors, regulators, employees, and other interested parties on environmental issues and cleanup progress on site.

2.1 BROOKHAVEN NATIONAL LABORATORY AND ISO 14001 STANDARD

The ISO 14001 Standard is globally recognized and defines the structure of an organization's EMS for purposes of improving environmental performance. The process-based structure of the ISO 14001 Standard is based on the "Plan-Do-Check-Act" improvement cycle. The standard requires an organization to develop an environmental policy, create plans to implement the policy, implement the plans, check progress and take corrective actions, and review the system annually to ensure its continuing suitability, adequacy, and effectiveness. To gain registration to the ISO 14001 Standard, an organization must comply with a set of 17 requirements that are listed and described in Table 2-1.

BNL's EMS was officially registered to the ISO 14001 Standard in July 2001 and was the first DOE Office of Science Laboratory to obtain third-party registration to this globally recognized environmental standard. To achieve registration, the Laboratory underwent an independent audit of its EMS to verify that the system conformed to all ISO 14001 requirements and that it was effectively implemented. The certification also requires BNL to undergo annual audits by an accredited registrar to assure that the system is maintained.

In 2004, an EMS Recertification Audit determined that BNL remains in conformance with the ISO 14001 Standard. In its recom-

mendation for continued certification, NSF-International Strategic Registrations, Ltd. (NSF-ISR) highlighted five examples of BNL's continual improvement, which include methods for documenting management input, internal auditing practices, and the work planning and environmental review process. The auditors also identified five minor nonconformances and three opportunities for improvement. A corrective action plan was prepared to track the minor nonconformances to closure.

On November 15, 2004, the ISO14001:1996 Standard was revised. The new standard, ISO 14001:2004, places a greater emphasis on the EMS as a tool to manage environmental aspects and on improved environmental performance. During future audits at BNL, NSF-ISR will assess BNL's conformance with the new standard. Changes to the standard are reflected in the elements listed in Table 2-1.

2.2 ENVIRONMENTAL, SAFETY, SECURITY, AND HEALTH POLICY

The cornerstone of an EMS is a commitment to environmental protection at the highest levels of an organization. In 2004, BNL incorporated the principles of its previous Laboratory-wide Environmental Stewardship Policy into a comprehensive Environmental, Safety, Security, and Health (ESSH) Policy. This new workplace policy, issued and signed by the Laboratory director, makes clear BNL's commitments to

Table 2-1. Elements of the Environmental Management System (EMS): Implementation of ISO 14001 at BNL.

Environmental Policy	The Environmental, Safety, Security, and Health Policy is a statement of BNL's intentions and principles regarding overall environmental, safety, security, and health performance. It provides a framework for planning and action. In the policy, BNL has reaffirmed its commitment to compliance, pollution prevention, cleanup, community outreach, and continual improvement.
Environmental Aspects and Impacts	<p>When operations have an environmental aspect, BNL implements the EMS to minimize or eliminate any potential impact. As required by the ISO 14001 Standard, BNL evaluates its operations, identifies the aspects of operations that can impact the environment, and determines which of those potential impacts are significant. BNL has determined that the following aspects of its operations have the potential to affect the environment:</p> <ul style="list-style-type: none"> ▪ Waste generation ▪ Atmospheric emissions ▪ Liquid effluents ▪ Storage or use of chemicals and radioactive materials ▪ Natural resource usage — power and water consumption ▪ Historical and cultural resources ▪ Environmental noise ▪ Disturbances to endangered species/protected habitats ▪ Soil activation ▪ Historical contamination ▪ Other facility-specific compliance aspects
Legal and Other Requirements	BNL has implemented and continues to improve the Standards Based Management System (SBMS), a BNL web-based system designed to deliver Laboratory-level requirements and guidance to all staff. New or revised requirements (e.g., new regulations) are analyzed to determine their applicability, and to identify any actions required to achieve compliance. This may involve developing or revising BNL documents or operating procedures, implementing administrative controls, providing training, installing engineered controls, or increasing monitoring.
Objectives, Targets, and Programs	<p>BNL's Performance Based Management System is designed to develop, align, balance, and implement the Laboratory's strategic objectives, including environmental objectives. Objectives and targets are developed by Fiscal Year (FY). The following objectives and targets, established in FY 2003, were continued in FY 2004:</p> <ul style="list-style-type: none"> ▪ Maintain and improve the EMS ▪ Achieve full compliance with applicable environmental requirements ▪ Integrate pollution prevention into work planning and expand participation within the Laboratory ▪ Improve communications, trust, and relationships with stakeholders on environmental programs ▪ Fully implement the BNL Groundwater Protection Program ▪ Ensure responsible stewardship of natural and historical resources on site ▪ Implement environmental restoration projects efficiently <p>Organizations within BNL develop action plans detailing how they will achieve their objectives and targets and commit the necessary resources to successfully implement both Laboratory-wide programs and facility-specific programs. BNL has a Pollution Prevention Program to conserve resources and minimize waste generation. BNL also has a budgeting system designed to ensure that priorities are balanced and that resources essential to the implementation and control of the EMS are provided.</p>
Resources, Roles, Responsibilities, and Authorities	All employees at BNL have specific roles and responsibilities in key areas, including environmental protection. Environmental and waste management technical support personnel assist the line organizations with developing and meeting their environmental responsibilities. Every BNL employee is required to develop a Roles, Responsibilities, Accountabilities, and Authorities document signed by the employee, their supervisor, and the supervisor's manager. Specifics on environment, safety, and health performance expectations are included in these documents.
Competence, Training, and Awareness	Extensive training on EMS requirements has been provided to staff whose responsibilities include environmental protection. The training program includes general environmental awareness for all employees, regulatory compliance training for selected staff, and specific courses for managers, internal assessors, EMS implementation teams, and operations personnel whose work can impact the environment.
Communication and Community Involvement	BNL continues to improve processes for internal and external communications on environmental issues. The Laboratory solicits input from interested parties such as community members, activists, civic organizations, elected officials, and regulators. This is accomplished primarily through the Community Advisory Council and the Brookhaven Executive Roundtable. At the core of the communication and community involvement programs are the Environmental Safety, Security, and Health Policy and the Community Involvement Plan.
Documentation	BNL has comprehensive, up-to-date Laboratory-wide environmental documents describing the EMS. Using the SBMS, staff can access detailed information on regulatory requirements, Laboratory-wide procedures, and manuals on how to control processes and perform work at BNL in a way that protects the environment. The SBMS has improved the quality, usability, and communication of Laboratory-level requirements.

(continued on next page)

Table 2-1. Elements of the Environmental Management System (EMS): Implementation of ISO 14001 at BNL (concluded).

Control of Documents	The SBMS includes a comprehensive document control system to ensure effective management of procedures and other requirements documents. When facilities require additional procedures to control their work, document control protocols are implemented to ensure that workers have access to the most current versions of procedures.
Operational Control	Operations at the Laboratory are evaluated for the adequacy of current controls to prevent impacting the environment. As needed, additional administrative or engineered controls are identified, and plans for upgrades and improvements are developed and implemented.
Emergency Preparedness and Response	BNL has an emergency preparedness and response program and specialized staff to provide timely response to hazardous materials or other environmental emergencies. This program includes procedures for preventing, as well as responding to, emergencies.
Monitoring and Measurement	Effluent and emission monitoring helps ensure the effectiveness of controls, adherence to regulatory requirements, and timely identification and implementation of corrective measures. BNL has a comprehensive, sitewide Environmental Monitoring Program. Monitoring results are reported to regulatory agencies and are summarized annually in the Site Environmental Report. In addition, BNL tracks and trends its progress and performance in achieving environmental objectives and performance measures.
Evaluation of Compliance	Specific environmental legislation and regulations are evaluated and assessed on a program- or facility-specific basis. BNL has established a documented procedure for periodically evaluating its compliance with relevant environmental regulations. This procedure is often integrated in an organization's Environmental, Safety, and Health inspection process, which is performed in a prioritized fashion by a team of experts, including one on environmental regulatory issues. Periodically, the environmental support organizations will perform a regulatory assessment in a particular topical area to verify the compliance status of multiple organizations throughout the Laboratory. Lastly, external regulatory agencies and/or technical experts may conduct independent audits of compliance.
Nonconformity, and Corrective and Preventive Actions	BNL continues to improve processes that identify and correct problems. A Lessons Learned Program to prevent recurrences, a sitewide Self-Assessment Program, and an electronic web-based assessment and action tracking system have been implemented.
Control of Records	EMS-related records, including audit and training records, are maintained to ensure integrity, facilitate retrieval, and protect them from loss.
Internal Audit	To periodically verify that the EMS is operating as intended, audits are conducted. These audits, which are part of the sitewide Self-Assessment Program, are designed to ensure that any nonconformance to the ISO 14001 Standard is identified and addressed. An independent accredited registrar also conducts ISO 14001 registration audits. In addition, compliance with regulatory requirements is verified through routine inspections, operational evaluations, and periodic audits.
Management Review	In addition to audits, a management review process has been established to involve top management in the overall assessment of environmental performance, the EMS, and progress toward achieving environmental goals. This review also identifies, as necessary, the need for changes to, and continual improvement of, the EMS.

environmental stewardship, the safety of its employees, and the security of the site. The policy continues as a statement of BNL's intentions and principles regarding overall environmental performance. It provides a framework for planning and action and is included in employee, guest, and contractor training programs. The ESSH Policy is posted throughout the Laboratory and on the BNL website at www.bnl.gov/eshq/ESSH.asp. It contains the following goals and commitments that focus on compliance, pollution prevention, cleanup, community outreach, and continual improvement:

- Meet all applicable ESSH laws and BNL's Standards-Based Management System

(SBMS), Integrated Safety Management, and Integrated Safeguards and Security Management requirements. The environmental requirements include more than 100 local, state, and federal laws and regulations; DOE Directives; Executive Orders; and numerous operating permits.

- Integrate hazard prevention/reduction, pollution prevention/waste minimization, resource conservation, security, and compliance into all BNL activities during planning and decision making. Adopt cost-effective practices that eliminate, minimize, or mitigate environmental impacts, including conserving natural re-

sources and adhering to the policy known as “E-ALARA”: ensuring that emissions, effluents, and waste generation are As Low As Reasonably Achievable.

- Define, prioritize, and aggressively prevent, correct, and/or clean up existing environmental, security, and occupational safety and health problems. This commitment encompasses removal or treatment of contamination caused by historical practices. It also includes strengthening the BNL Environmental Monitoring Program to ensure that controls designed to protect the environment are working, and to provide early detection of potential threats to the environment (see Section 2.4.3).
- Work with stakeholders to help them address their ESSH needs. Openly communicate with stakeholders about program planning, progress, and performance (see Section 2.4.2).
- Continually improve the EMS and the Laboratory’s environmental performance. Establish appropriate environmental objectives and performance indicators to guide these efforts and measure progress. To maintain certification, BNL employs proactive measures to prevent problems. When problems do occur, the approach is to investigate the root cause and take corrective actions, as appropriate.

2.3 PLANNING

The planning requirements of the ISO 14001 Standard require BNL to identify the environmental aspects and impacts of its activities, products, and services; to evaluate applicable legal and other requirements; to establish objectives and targets; and to create action plans to achieve the objectives and targets.

2.3.1 Environmental Aspects

An environmental aspect is any element of an organization’s activities, products, and services that can interact with the environment. As required by the ISO 14001 Standard, BNL evaluates its operations, identifies the aspects that can impact the environment, and determines which of those impacts are significant.

BNL’s criteria for significance are based on actual and perceived impacts of its operations and on regulatory requirements. BNL utilizes several processes to identify and review environmental aspects. Key among these is the Process Assessment Procedure. This procedure is an evaluation that is documented on a Process Assessment Form (PAF). The PAF consists of a written process description, a detailed process flow diagram, a regulatory determination of all process inputs and outputs, identification of pollution prevention opportunities, and identification of any Assessment, Prevention, and Control measures that should be considered. Environmental professionals work closely with Laboratory personnel to ensure that environmental requirements are integrated into each process. Aspects and impacts are evaluated annually to ensure that the significant aspects and potential impacts continue to reflect stakeholder concerns and changes in regulatory requirements. BNL’s list of aspects and significant criteria remained unchanged in 2004.

2.3.2 Legal and Other Requirements

To implement the compliance commitments of the ESSH Policy and to meet its legal requirements, BNL has systems in place to review changes in federal, state, or local environmental regulations and to communicate those changes to affected staff. Laboratory-wide procedures for documenting these reviews and recording the actions required to ensure compliance are available to all staff through BNL’s web-based SBMS subject areas.

2.3.3 Objectives and Targets

The establishment of environmental objectives and targets is accomplished through BNL’s Performance Based Management System. This system is designed to develop, align, balance, and implement the Laboratory’s strategic objectives, including environmental objectives. The system drives BNL’s improvement agenda by establishing a prioritized set of key objectives, called “critical outcomes.” BSA works with DOE to clearly define expectations and performance measures. Factors for selecting environmental priorities include:

- Significant environmental aspects
- Risk and vulnerability (primarily, threat to the environment)
- Legal requirements (laws, regulations, permits, enforcement actions, and memorandums of agreement)
- Commitments (in the ESSH Policy, to regulatory agencies, and to the public)
- Importance to DOE, the public, and other stakeholders
- Current and past performance trends

Laboratory-level objectives and targets are developed on a Fiscal Year (FY) schedule. In FY 2004 (October 1, 2003 through September 30, 2004), BNL's environmental objectives included:

- Maintain and improve the EMS
- Achieve full compliance with applicable environmental requirements
- Integrate pollution prevention into work planning and expand participation within the Laboratory
- Improve communications, trust, and relationships with stakeholders on environmental programs
- Fully implement the BNL Groundwater Protection Management Program
- Ensure responsible stewardship of natural and cultural resources on site
- Implement environmental restoration projects efficiently

2.3.4 Environmental Management Programs

Each organization within BNL develops an action plan detailing how they will achieve their environmental objectives and targets and commit the resources necessary to successfully implement both Laboratory-wide and facility-specific programs. BNL has a budgeting system designed to ensure that priorities are balanced and to provide resources essential to the implementation and control of the EMS.

The Laboratory has developed and funded several important environmental programs to further integrate environmental stewardship into all facets of BNL's missions.

2.3.4.1 Compliance

BNL has an extensive system to help ensure

full compliance with all applicable environmental regulatory requirements and permits. Legislated compliance is outlined by the National Emission Standards for Hazardous Air Pollutants (NESHAPs), State Pollutant Discharge Elimination System (SPDES), and Resource Conservation and Recovery Act (RCRA). Other compliance at BNL involves special projects or initiatives, such as upgrading petroleum and chemical storage tank facilities, upgrading the sanitary sewer system, closing underground injection control devices, retrofitting or replacing air conditioning equipment refrigerants, and managing legacy waste. See Chapter 3 for a thorough discussion of these programs and their status.

2.3.4.2 Groundwater Protection

BNL's Groundwater Protection Management Program is designed to prevent impacts to groundwater and to restore groundwater quality by integrating pollution prevention efforts, monitoring groundwater restoration projects, and communicating performance. BNL has also developed a Groundwater Protection Contingency Plan that defines an orderly process for quickly taking corrective actions in response to unexpected monitoring results. Key elements of the groundwater program are the full and timely disclosure of any off-normal occurrences and regular communication on the performance of the program. Chapter 7 provides additional details about this program and monitoring results for 2004.

2.3.4.3 Waste Management

As a byproduct of the world-class research it conducts, BNL generates a large range of waste. This includes materials common to many businesses and industries, such as aerosol cans, batteries, paints, and oils. However, BNL's unique scientific activities also generate waste streams that are subject to additional regulation and special handling, including radioactive, hazardous, and mixed waste.

BNL's Environmental and Waste Management Services Division (EWMSD) is responsible for the collection, transportation, storage, and off-site disposal of waste generated at BNL. The

BNL Waste Management Facility (WMF) was designed for handling hazardous, industrial, radioactive, and mixed waste and is comprised of three staging areas: a facility for hazardous waste, regulated by RCRA; a mixed-waste building for waste that is both hazardous and radioactive; and a reclamation building for radioactive material. The RCRA and mixed-waste buildings are managed under a permit issued by the New York State Department of Environmental Conservation (NYSDEC). These buildings are used for short-term storage of waste before it is packaged or consolidated for off-site shipment to permitted treatment and disposal facilities. In 2004, BNL generated the following types and quantities of waste from routine operations:

- Hazardous waste: 6.2 tons
- Mixed waste: 65 ft³
- Radioactive waste: 4,786 ft³

While waste generation rates for 2004 were similar to 2003, these quantities represent significant reductions from previous years, as shown in Figures 2-1a through 2-1c. Routine operations are defined as ongoing industrial and experimental operations. The picture is not complete, however, without consideration of waste generated from nonroutine or one-time events and waste generated from environmental restoration activities. BNL is currently cleaning up facilities and areas containing radioactive and chemical contamination resulting from historical operations. Waste recovered through restoration and decommissioning activities is managed by the Environmental Restoration (ER) group with oversight by BNL's EWMSD. Nonroutine waste includes construction and demolition waste, environmental restoration waste, legacy waste, lead-painted debris, lead shielding, and PCB waste. Figures 2-1d through 2-1f show wastes generated under the ER Program, as well as nonroutine operations. Waste generation from these activities has varied significantly from year to year. This was expected, as environmental restoration activities moved from remedial investigations and feasibility studies to remedial actions, which have changed annually based on the progress of BNL's cleanup schedule.

2.3.4.4 Pollution Prevention and Minimization

The BNL Pollution Prevention (P2) Program is an essential element for the successful accomplishment of BNL's broad mission. It 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.

DOE has incorporated pollution prevention and waste reduction goals into its contract with BSA, BNL's ESSH Policy, and the critical outcomes associated with the Laboratory's operating contract. Key elements of the P2 Program include:

- Eliminate or reduce emissions, effluents, and waste at the source where possible, and ensure that they are as low as reasonably achievable (i.e., uphold the E-ALARA policy)
- Procure environmentally preferable products (known as "affirmative procurement")
- Conserve natural resources and energy
- Reuse and recycle materials
- Achieve or exceed BNL/DOE waste minimization, P2, recycling, and affirmative procurement goals
- Comply with applicable requirements (e.g., New York State Hazardous Waste Reduction Goal, Executive Orders, etc.)
- Reduce waste management costs
- Identify funding mechanisms for evaluating and implementing P2 opportunities
- Implement P2 projects
- Improve employee and community awareness of P2 goals, plans, and progress

Proposals for funding pollution prevention opportunities are submitted to the BNL P2 Council. In January 2004, the P2 Council announced the winners of the Pollution Prevention funding competition. Eight proposals were funded, investing approximately \$86,000. The anticipated annual savings from these projects is estimated at \$60,500, for an average payback period of 1.3 years.

The efforts of the BNL P2 and recycling programs have achieved significant reductions in waste generated by routine operations, as shown

**Figure 2-1a.
Hazardous Waste Generation
from Routine Operations,
1994 – 2004.**

**Figure 2-1b.
Mixed Waste Generation
from Routine Operations,
1994 – 2004.**

**Figure 2-1c.
Radioactive Waste Generation
from Routine Operations,
1994 – 2004.**

Figure 2-Id.
Hazardous Waste Generation from
ER and Nonroutine Operations,
1997 – 2004.

Figure 2-Ie.
Mixed Waste Generation from
ER and Nonroutine Operations,
1997 – 2004.

Figure 2-If.
Radioactive Waste Generation
from ER and Nonroutine Operations,
1997 – 2004.

in Figures 2-1a through 2-1c. This continues a positive trend and is further evidence that pollution prevention planning is well integrated into the Laboratory's work planning process. These positive trends are also driven by EMS emphasis on preventing pollution and establishing objectives and targets to reduce environmental impacts.

Implementation of pollution prevention opportunities, recycling programs, and conservation initiatives has significantly reduced both waste volumes and management costs. In 2004, these efforts resulted in more than \$1.6 million in cost avoidance or savings and approximately 2.2 million pounds of materials being reduced, recycled, or reused. Table 2-2 describes the projects that were implemented through 2004 and includes the number of pounds of materials reduced, reused, or recycled and the estimated cost benefit of each project.

BNL also has an active and successful solid waste recycling program, which involves all employees. In 2004, BNL collected more than 185 tons of office paper for recycling. Cardboard, bottles and cans, construction debris, motor oil, scrap metals, lead, automotive batteries, printer and toner cartridges, fluorescent light bulbs, drill press machine coolant, and antifreeze are also recycled. Table 2-3 shows the total number of tons (or units) of the materials recycled in 2004.

2.3.4.5 Water Conservation

BNL has a strong water conservation program and has achieved dramatic reductions in water use since the mid 1990s. The Laboratory continually evaluates water conservation as part of facility upgrades or new construction initiatives. These efforts include more efficient and expanded use of chilled water for cooling and heating, ventilation and air conditioning systems, and reuse of once-through cooling water for other systems such as cooling towers. BNL's goal is to reduce the consumption of potable water and reduce the possible impact of clean water discharges on Sewage Treatment Plant operations. Figure 2-2 shows the 10-year trend of water consumption. As of 2004, BNL has used less than half as much water as was used in 1995—over 800 million gallons less.

2.3.4.6 Energy Management and Conservation

Since 1979, BNL's Energy Management Group has been working to reduce energy use and costs by identifying cost-effective, energy-efficient projects, by monitoring energy use and utility bills, and by assisting in obtaining the least expensive energy sources possible. The group is responsible for developing, implementing, and coordinating BNL's *Energy Management Plan* (2003a).

BNL has more than 4 million square feet of building space. Many BNL scientific experiments use particle beams generated and accelerated by electricity, with the particles controlled and aligned by large electromagnets. In 2004, BNL used approximately 276 million kilowatt hours (kWh) of electricity, 4.5 million gallons of fuel oil, 39.1 thousand gallons of propane, and 710 thousand ft³ of natural gas. Fuel oil and natural gas produce steam at the Central Steam Facility (CSF). Due to market conditions, fuel oil was predominately used in 2004, resulting in a cost savings of approximately \$940,000. See additional information on natural gas and fuel oil use in Chapter 4.

BNL is a participant in the Long Island Power Authority's (LIPA) Peak Load Reduction Curtailment Program. Through this program, the Laboratory has agreed to reduce electrical demand during critical days throughout the summer when LIPA expects customer demand to meet or exceed the company's available supply. In return, BNL receives a rebate for each megawatt reduced on each critical day. In 2004, participation in this program produced a rebate of \$24,000. The Laboratory's participation is significant to LIPA; BNL's portion represents more than 12 percent of the 95-megawatt load-curtailement program total, making the Laboratory one of the single largest program contributors. BNL also agreed to keep electric loads at a minimum during the summer, in part by curtailing operations at RHIC. This scheduling allowed BNL to earn over \$1 million in electric billing credits from the New York Power Authority (NYPA) as discussed below.

In 2004, a project to reduce the energy necessary to dry compressed air from the Central Chilled Water Facility went into operation. The

Table 2-2. BNL Pollution Prevention, Waste Reduction, and Recycling Projects.

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled or Conserved in 2004	Waste Type	Potential Cost for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Savings	Project Description Details *
Automotive Waste	Substitution	510	Hazardous Waste	\$1,020	\$1,000	\$1,000	In 2004, solvent-based brake cleaners were replaced, reducing the hazards associated with their use and disposal.
Mercury Utility Devices	Substitution	60	Hazardous Waste	\$1,750	\$2,500	\$1,750	Approximately 60 lb of mercury-containing devices were removed from Buildings 463 and 490 in 2004. Savings are based on the cost of one mercury spill and cleanup.
PCB Oils	Retrofit	1,200	Hazardous Waste	\$2,850	\$3,450	\$2,850	Approximately 150 gal of PCB-laden oil were removed from the ATF Klystron in 2004. Savings are based on the cost of one PCB spill and cleanup.
Organic Solvents	Substitution	678	Hazardous Waste	\$1,355	\$36,500	\$26,000	Life Sciences purchased a Microwave Peptide Synthesizer in 2004 to significantly reduce the amount of hazardous wastes generated. Saves ~1,000 work hours/year (reflected in cost savings).
Organic Solvents	Purification/Reuse	480	Hazardous Waste	\$960	\$24,000	\$10,915	The primary cost saving of the BES solvent purification system, new in 2004, is in not purchasing new solvent.
Cooling Water	Reuse	80,000	Deionized water	\$0	\$6,000	\$10,000	A closed-cycle water recycling system for the Building 480 melt spinner was purchased in 2004. This saves a minimum of 10,000 gal of ultra-pure water and extends the life expectancy of equipment worth \$100,000.
PCB Oils	Removal	3,110	Hazardous Waste	\$6,220	\$10,000	\$2,850	In 2004, ~300 gal of pure PCB oil were drained from the transformer and rectifier in Building 901 (former PET Facility). Also removed were 30 PCB capacitors and 11 PCB transformers. Savings are based on the cost of one PCB spill and cleanup.
Mercury Utility Devices	Substitution	40	Hazardous Waste	\$2,300	\$2,500	\$1,750	The Occupational Medical Clinic replaced mercury-containing equipment with non mercury-containing equipment in 2004. Savings are based on the cost of one mercury spill and cleanup.
Radioactive Waste	Source Reduction	1,500	Radioactive Waste	\$6,000	\$0	\$6,000	A sorting table was purchased in 2003 for the Waste Yard, so clean waste could be sorted from radioactive waste.
Radioactive Emissions	Emission Reduction	0	Radioactive Emissions			\$0	A shroud was installed over the 16-inch diameter shaft in the Hot Cell of the BLIP, isolating cooling water from the rapidly moving air of the exhaust system and allowing radiological decay within the water system. Slowing the diffusion into the hot cell air will effectively reduce gaseous emissions into the exhaust stack, as these radionuclides have very short half lives.
Radioactive Waste generated through wet chemistry	Waste Minimization	30	Mixed waste/Liquid Radioactive Waste	\$17,600	\$0	\$22,500	The 2003 purchase of a Kinetic Phosphorescence Analyzer (KPA) system for uranium analysis eliminates mixed waste generation in this chemistry laboratory, reduces by 90% the volume of liquid waste, reduces by 90% the amount of radioactive material handled, minimizes exposure to uranium by laboratory personnel, and decreases labor time by 75%.

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Table 2-2. BNL Pollution Prevention, Waste Reduction, and Recycling Projects (continued).

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled or Conserved in 2004	Waste Type	Potential Cost for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Savings	Project Description Details *
Radioactive Waste from labeled chemicals	Waste Minimization/Volume Reduction	0	Solid Radioactive Waste	\$2,168	\$0	\$2,168	A vial crusher for glass vials, pipettes, and other glassware was purchased in 2003.
Radioactive and Mixed Wastes from radio-labeled chemicals	Waste Minimization	112	Mixed Waste	\$27,690	\$0	\$27,690	A microplate scintillation counter to reduce mixed waste generation was purchased in 2003.
Pump Oil	Substitution	51	Hazardous Waste / Industrial Waste	\$3,520	\$0	\$3,520	In 2003, oil-displacement pumps were replaced with dry pumps for both laboratory and research aircraft missions.
Photographic Waste	Substitution	3,840	Hazardous Waste / Industrial Waste	\$7,600	\$0	\$16,489	This photographic processor, purchased in 2003, reduces the amount of chemicals used and waste generated by up to 80%.
Electrophoretic Mini-Gels	Microscale Chemical Use	2,200	Hazardous Waste - Lab Pack	\$10,400	\$0	\$10,400	This 2002 purchase minimized silver waste from silver-staining electrophoretic mini-gels. Savings reflect avoided waste disposal costs and lower material purchase costs (\$6,000).
Hydraulic Oil	Product Substitution	1,000	Industrial Waste	\$15,000	\$0	\$15,000	In 2002, garbage trucks were retrofitted with steel-braided hydraulic lines and vegetable-based hydraulic oil. This project reduced the potential for reportable spills and associated cleanup costs.
Hydraulic Oil	Product Substitution	3,000	Industrial Waste	\$26,000	\$0	\$26,000	Hydraulic lift bays in the Motor Pool Shop were retrofitted to vegetable-based hydraulic oil in 2002. This project minimized the potential for petroleum-based hydraulic oil leaks and spills and associated cleanup costs.
Sewage Sludge	Volume Reduction	234,000	Radioactive Waste	\$910,000	\$0	\$910,000	In 2002, disposal of 60,000 gal of radioactive Sewage Treatment Plant liquid waste by a contractor would have cost \$910,000. Instead, the waste was dried using rollofs, absorbent, and lime and shipped via rail to a disposal facility. A second drying bed was built to dry sludge (96% volume reduction) from the anaerobic sludge digester.

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Table 2-2. BNL Pollution Prevention, Waste Reduction, and Recycling Projects (continued).

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled or Conserved in 2004	Waste Type	Potential Cost for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Savings	Project Description Details *
CO ₂ Snow Cleaning	Source Reduction	0	Hazardous Waste / Industrial Waste	\$5,000	\$0	\$0	In 2002, equipment was purchased to evaluate CO ₂ snow cleaning for NLS, Instrumentation, and CAD applications. This project has the potential to reduce solvent usage (hazwaste), and aqueous cleaning wastes (industrial waste). So far, success has been limited, due to condensation.
Film and other radioisotopic imaging	Substitution	300	Hazardous Waste / Industrial Waste	\$22,000	\$0	\$22,000	In 2002, replacement of film-based autoradiography and other radioisotopic imaging with a Phosphor Imager reduced hazardous waste generation by 200 lb and industrial waste generation by 100 lb. Additional projected savings are in annual supply costs and labor reduction.
Digital Imaging System	Substitution	282	Hazardous Waste / Radioactive Waste / Industrial Waste	\$25,000	\$0	\$25,000	Reduction of hazardous (134 lb), radioactive (80 lb), and industrial (68 lb) waste with purchase of a digital imaging system in 2002. Additional projected savings are in annual supply costs and labor reduction.
Fluorescence-Based Assay	Substitution	200	Mixed Waste	\$30,550	\$0	\$30,550	In 2002, a project was funded for development of a fluorescence-based assay for the DNA-dependent protein kinase (DNA-PKcs), replacing the phosphorus-33 assay.
Lead Acid Batteries	Recycled	9,800	Hazardous Waste	\$19,600	\$0	\$19,600	Estimate 40 lbs/battery and avoided disposal costs as hazardous waste.
Ion Exchange wastewater	Source Reduction	1250	Hazardous and Sanitary Wastewater	\$2,500	\$100	\$2,400	In 2000, prefilters were added to the deionization system to polish makeup water entering the ion exchange system. This extended the useful life of the ion exchange resins, requiring less frequent regeneration. The regeneration process generates hazardous and sanitary waste. There is a small annual cost for replacement supplies.
Tritium Exit Signs	Source Reduction	568	Mixed Waste	\$119,280	\$10,650	\$108,630	In 2004, 142 tritium exit signs were removed from service, returned to the manufacturer, and replaced with energy-efficient light-emitting diode (LED) signs. This ongoing project reduces the risk of tritium gas release and avoids eventual disposal as mixed waste.
Cooling Water	Reuse	34,850	Radioactive Waste	\$80,155	\$0	\$80,155	Approximately 18,000 gal (153,000 lb) of cooling water were reused in the main magnet cooling water system, avoiding disposal as radioactive wastewater.
Short Half-life waste	Decay in Storage	627	Radioactive Waste	\$1,499	\$0	\$1,499	Short half-life isotopes, particularly phosphorus-32 and phosphorus-33, are frequently used in Life Sciences experiments. In 2004, wastes from these operations (10 ft ³) were managed in accordance with BNL decay-in-storage requirements, rendering the wastes eligible for volumetric release.

(continued on next page)

Table 2-2. BNL Pollution Prevention, Waste Reduction, and Recycling Projects (concluded).

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled or Conserved in 2004	Waste Type	Potential Cost for Treatment and Disposal	Cost of Recycle, Prevention	Estimated Cost Savings	Project Description Details *
Lubricating Oil	Energy Recovery	8,000	Industrial Waste	\$16,500	\$500	\$16,500	In 2004, ~8,000 lb (1,000 gal) of lubricating oils were collected, tested for suitable use as waste oil fuel, and used for energy production at the Central Steam Facility. Avoided disposal cost was \$16,500. Cost of testing (\$500) was offset by fuel use savings (\$50/gal).
Cooling Tower Chemicals	Source Reduction	6,375	Industrial Waste	\$15,000	\$0	\$15,000	In 2001, ozone water treatment units were installed on cooling towers at two RHIC experiments to provide biological control of cooling water. These systems eliminate the need for water treatment chemicals (typically toxic biocides), save labor, and reduce analytical costs for monitoring cooling tower blowdown.
Blasocut Machining Coolant	Recycled/ Reused	51,600	Industrial Waste	\$103,200	\$0	\$114,500	Central Shops Division operates a recycling system that reclaims Blasocut machining coolant and supplies it Laboratory-wide. 6,450 gal (51,600 lb) of Blasocut lubricant were recycled in 2004. Recycling involves aeration, centrifuge, and filtration. This avoids cost of disposal as industrial waste plus an avoided cost of procurement of 6 drums of concentrate (\$800/drum) and 130 drums for waste (\$50/drum). Cost of recycle is estimated to be the same as cost of procurement and preparation of proper dilution for use.
Used Motor Oil	Energy Recovery	30,880	Industrial Waste	\$65,660	\$0	\$65,660	Used motor oil from the motor pool and the on-site gas station is picked up for free by Strehel's Laundry Service and used to fire their waste oil dryers. In 2004, 3,860 gal of oil were picked up, avoiding cost for disposal and 78 drums for shipping (\$50/drum).
Office Paper	Recycled	370,000	Sanitary Waste	\$16,650	\$0	\$16,650	Estimate \$90/ton for avoiding disposal as trash.
Cardboard	Recycled	358,000	Sanitary Waste	\$16,110	\$0	\$16,110	Estimate \$90/ton for avoiding disposal as trash.
Scrap Metal	Recycled	256,000	Sanitary Waste	\$11,520	\$0	\$11,520	Estimate \$90/ton for avoiding disposal as trash.
Bottles/Cans	Recycled	44,000	Sanitary Waste	\$1,980	\$0	\$1,980	Estimate \$90/ton for avoiding disposal as trash.
Construction Debris	Recycled	734,000	Sanitary Waste	\$16,515	\$0	\$16,515	Estimate \$45/ton for avoiding disposal as trash.
	TOTALS	2,238,543		\$1,611,152	\$97,200	\$1,661,151	

* Cost savings of projects funded by the BNL Pollution Prevention Council will be tracked for three years.

Table 2-3. BNL Recycling Program Summary.

Recycled Material	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Mixed paper	155	136	197	220	106	196	204	370	336	246	209	182	185
Cardboard	21	81	164	85	101	103	97	124	132	127	157	176	179
Bottles/Cans	12	12	18	11	15	21	22	21	20	29	19	23	22
Tires	9	21	7	11	17	18.6	11.5	15.2	0	0	3.5	12.3	11
Construction debris	809	495	495	627	837	799	527	352	243	289	304	334	367
Used motor oil (gallons)	–	–	4,000	3,350	4,275	4,600	3,810	3,570	3,295	3,335	1,920	3,920	3,860
Metals	201	210	33	153	158	266	64	47	534	38	48	193	128
Lead	–	–	–	–	–	4.4	3.7	0.7	2.5	0	0	–	5
Automotive batteries	–	5	0.81	0.72	6.8	4.3	2.1	1.1	2.2	4.8	6.3	4.6	5
Printer/Toner cartridges (units)	–	–	–	–	–	–	1,480/175	1,575/510	–	363	449	187	105
Fluorescent bulbs (units)	–	–	–	–	13,664	12,846	867	25,291	5,874	17,112	25,067	13,611	12,592
Blasocut coolant (gallons)	–	–	–	–	–	–	–	3,575	7,500	10,660	8,180	5,030	6,450
Antifreeze (gallons)	–	–	–	–	55	276	448	145	110	200	0	165	325
Tritium exit signs (each)	–	–	–	–	–	–	–	–	185	190	28	181	142
Smoke detectors (each)	–	–	–	–	–	–	–	–	–	171	40	0	0
Road base											2,016	0	2,666

Notes:

All units are tons unless otherwise noted.

– Denotes not recycled in that year or data not available.

Figure 2-2. BNL Water Consumption Trend.

new energy-efficient drying system is estimated to save over 265,000 kWh and \$14,000 annually.

The National Energy Conservation Policy Act, as amended by the Federal Energy Management Improvement Act of 1988 and the Energy Policy Act of 1992, requires federal agencies to apply energy conservation measures and to improve federal building design to reduce energy consumption per square foot. Current goals at BNL are to reduce energy consumption per square foot, relative to 1985, by 20 percent in 2000, 30 percent by 2005, and 35 percent by 2010. BNL's energy use in 2004 was 23 percent less than in 1985 (see Figure 2-3).

BNL also maintains a contract with NYPA that resulted in an overall cost avoidance of \$14 million in 2004. Participation in NYPA's 2004 Load Curtailment Program produced an additional rebate worth \$1 million. BNL will continue to seek alternative energy sources to meet future energy needs, support federally required "green" initiatives, and reduce energy costs. Plans for a 65,000-ft² Research Support Building and 94,500-ft² Center for Functional Nanomaterials qualify for Leadership in Energy and Environmental Design certification under the U.S. Green Building Council, a coalition of leaders from across the building industry work-

ing to promote buildings that are environmentally responsible, profitable, and healthy places to live and work.

2.3.4.7 Natural and Cultural Resource Management Programs

BNL continues to enhance its Natural Resource Management Program in cooperation with the U.S. Fish & Wildlife Service and the Upton Ecological and Research Reserve Technical Advisory Group (TAG). BNL also continues to enhance its Cultural Resource Management Program. A BNL Cultural Resource Management Plan has been developed to identify and manage properties that are determined to be eligible or potentially eligible for inclusion on the National Register of Historic Places. For more information about these programs, see Chapter 6.

2.3.4.8 Environmental Restoration

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly known as Superfund, was enacted by Congress on December 11, 1980. As part of CERCLA, EPA established the National Priorities List (NPL), which identifies sites where cleanup of past contamination is re-

Figure 2-3. BNL Building Energy Performance, 1985 – 2010

quired. BNL is listed on the NPL, with 27 other Long Island sites, 12 of which are in Suffolk County (see <http://www.epa.gov/superfund/sites/npl/ny.htm>).

Each step of the Superfund cleanup process is reviewed and approved by DOE, EPA, and NYSDEC, under a contract called the “Interagency Agreement.” This agreement was formalized in 1992. Most of the contamination at BNL is associated with past accidental spills and outmoded practices for handling, storing, and disposing of chemical and radiological waste.

BNL follows the CERCLA process, which includes the following steps:

- Conduct a Remedial Investigation to characterize the nature and extent of contamination and assess the associated risks
- Prepare a Feasibility Study and Proposed Plan to list and evaluate Remedial Action alternatives and present the proposed best alternative
- Issue a Record of Decision (the remedy/corrective action agreed to by DOE, EPA, and NYSDEC)
- Perform the Remedial Design/Remedial Action, which includes final design, construction specifications, and carrying out the remedy selected

The BNL site was initially divided into seven Operable Units (OUs), some of which were later combined (OU I/VI and OU II/VII). Significant progress was made in environmental restoration in 2004. Table 2-4 provides a description of each OU and a summary of environmental restoration actions taken. The goal is to complete cleanup activities and install all groundwater treatment systems by 2006 (see Chapter 7 and Volume II of the SER, *Groundwater Status Report*, for further details).

2.3.4.9 EPA Performance Track Program

BNL was accepted into the EPA’s Performance Track Program in 2004. The program recognizes top environmental performance among participating U.S. facilities of all types, sizes, and complexity, both public and private. Performance Track was established by EPA as the “gold standard” for facility-based environmental performance—a standard that participat-

ing members strive to attain as they “meet or exceed their performance commitment.” Under this program, partners provide leadership in many areas, including preventing pollution at its source. The program currently has just over 360 members nationwide.

The Performance Track Program requires that sites commit to several improvement goals for a 3-year period and report on the progress of these goals annually. Below is a brief description of BNL’s goals and the progress for 2004.

- *Increase BNL’s land and habitat conservation.* Due to the demolition of several buildings, the Laboratory recovered open land and began to implement habitat conservation under the BNL *Natural Resource Management Plan* (2003b) and the BNL *Wildland Fire Management Plan* (2003c). These plans call for managing vegetation through various means, including planting native vegetation, recovering construction (demolition) sites, and reintroducing prescribed fires to manage the ecosystem. In 2004, BNL conducted its first prescribed fire on a 7-acre parcel of land. Two acres of surrounding grassed firebreak and 5 acres of oak forest were put into a fire rotation to ensure the health of the forest, which will be continually monitored. In addition, 9 acres of formerly mowed areas are being reverted back to native trees and shrubs. In total, BNL recovered 16 acres of land toward a 30-acre goal by 2006.
- *Reduce radioactive air emissions.* BNL’s initial reduction of radioactive air emissions concentrates on emissions from the Brookhaven Linac Isotope Producer. In 2003, BNL released approximately 3,725 curies of short-lived isotopes (with half-lives less than 30 minutes) from this facility. In 2004, an emissions reduction of 27 percent was realized due to reduced hours of operation. Additional reductions are expected in 2005 with the use of a lucite enclosure around the target assembly to minimize evaporative and gaseous losses from the beam interactions with the target cooling water. The overall radiological air

CHAPTER 2: ENVIRONMENTAL MANAGEMENT SYSTEM

Table 2-4. Summary of BNL 2004 Environmental Restoration Activities.

Project	Description	Environmental Restoration Program Actions
Soil Projects	OU I OU II OUVII	<ul style="list-style-type: none"> ▪ Mobilized contractor and commenced the soil remediation at the former Hazardous Waste Management Facility. ▪ Mobilized the contractor and commenced the underground storage tank (UST) removal and soil remediation at the Waste Concentration Facility. ▪ Completed excavation and disposal of PCB-contaminated soil at the Building 96 former scrap yard.
Groundwater Projects	OU III	<ul style="list-style-type: none"> ▪ Completed construction and began operations of four groundwater treatment systems to treat volatile organic compounds (VOCs) that have migrated beyond BNL property in East Yaphank and Manorville (Industrial Park East, North Street, North Street East, and LIPA/Airport). ▪ Continued operations of the Strontium (Sr-90) groundwater treatment system for the Chemical Holes plume, as well as the remaining VOC treatment systems. ▪ Completed construction of an on-site Sr-90 groundwater treatment system for the Brookhaven Graphite Research Reactor (BGRR)/Waste Concentration Facility groundwater plume. ▪ Applied the oxidizer potassium permanganate to degrade VOC contamination at the Building 96 groundwater plume. ▪ Regulators approved a Petition for Shutdown of the Carbon Tetrachloride groundwater treatment system. The system was placed on standby in August and will continue to be monitored and restarted, if necessary. ▪ Continued monitoring of the High Flux Beam Reactor (HFBR) tritium plume. ▪ An Explanation of Significant Differences (ESD) to the Operable Unit (OU) III Record of Decision (ROD) was prepared, reviewed by the regulators, and made available to the public to obtain their input. The ESD proposed active treatment of the Magothy aquifer VOC contamination, changes to the overall cleanup timeframe for the Sr-90 plumes, and documented the need for no further action for Building 96 anomalies. ▪ Continued characterization and monitoring of tritium in groundwater from g-2 activated soil. A milestone extension request was approved by the regulators that called for the collection of additional groundwater monitoring data, followed by the preparation and submittal of a Focused Feasibility Study and ROD in 2006. ▪ During 2004, 1.5 billion gallons of groundwater were treated and 652 pounds of VOCs were removed. Since the first groundwater treatment system started operating in December 1996, approximately 4,800 pounds of VOCs have been removed from more than 8.4 billion gallons of groundwater.
	OU IV	<ul style="list-style-type: none"> ▪ Continued groundwater monitoring.
	OU VI	<ul style="list-style-type: none"> ▪ Completed construction and began operation of a groundwater treatment system to treat ethylene dibromide that has migrated beyond BNL property in Manorville.
	Groundwater Monitoring	<ul style="list-style-type: none"> ▪ Completed the BNL 2003 Groundwater Status Report. ▪ Collected and analyzed 1,889 groundwater samples from 703 monitoring wells. ▪ Updated the Environmental Monitoring Plan.
Peconic River	OU V	<ul style="list-style-type: none"> ▪ Completed the Phase 1 on-site remediation of the Peconic River. ▪ Commenced the Phase 2 off-site remediation of the Peconic River. ▪ DOE signed the ROD and forwarded to the Regulatory Agencies for approval.
Reactors	BGRR	<ul style="list-style-type: none"> ▪ Completed the draft ROD for the end state of the BGRR and submitted for regulatory approval. ▪ Removed the below grade duct filters and most of the primary liner.
	HFBR	<ul style="list-style-type: none"> ▪ Continued long-term surveillance and maintenance activities.
	BMRR	<ul style="list-style-type: none"> ▪ Reactor startup source and all sensitive nuclear material removed; reactor control rods removed; mercury-containing equipment removed; Halon system inventory removed; hazardous chemicals such as cadmium and gadolinium nitrite removed; Building 492 well house charcoal filtration system removed; all associated piping removed and capped; and miscellaneous D₂O (heavy water) formerly used as shielding removed.

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emissions reduction goal is 30 percent by 2006.

- *Reduce BNL's use of ozone-depleting substances (ODS), specifically Class I ODS.* In 2003, BNL's baseline inventory of ODS included 124,446 pounds of CFC-11 equivalent. ODS reduction activities in

2004 included: the replacement of a 130-ton CFC-11 chiller normally containing 550 pounds of refrigerant, with an 80-ton HFC-134a (non ozone-depleting) chiller; recovery/reclamation of refrigerant from two 650-ton CFC-11 chillers normally containing 1,400 pounds CFC-11 each, af-

ter the associated building was connected to BNL's Central Chilled Water Facility; recovery of refrigerant from two 110-ton CFC-11 chillers normally containing 550 pounds of CFC-11 each, after the associated building was connected to BNL's Central Chilled Water Facility; and shipment of 5,284 pounds of excess Halon 1301 and approximately 175 pounds of excess Halon 1011 to the DOE Savannah River Site ODS Repository. In total, BNL reduced its ODS inventory to 67,135 CFC-11 equivalent pounds and is working toward meeting its overall site inventory reduction of 65,500 pounds by 2006.

- *Reduce BNL's hazardous materials use.* BNL will concentrate on facility-wide mercury reduction for its initial hazardous material reduction goal. In 2004, BNL conducted an in-depth inventory of mercury-containing devices. Currently, there are approximately 400 to 500 pounds of mercury throughout the site. Most of this inventory is from instrumentation (e.g., thermometers, thermostats, and pressure-regulating devices). Approximately half of the inventory is considered nonessential and can be replaced by devices that do not contain mercury. In 2004, the following efforts to reduce the BNL mercury inventory were implemented: removed and disposed of approximately 260 elemental mercury thermometers; removed and disposed of 13 pounds of elemental mercury from research laboratory spaces; and removed and disposed of approximately 20 mercury-bearing devices including electrodes, psychrometers, and barometers/manometers. By the end of 2004, the total BNL mercury inventory was approximately 393 pounds.
- *Other contributions to improve site conditions.* Although this is not specifically reported to EPA under the Performance Track program, in 2004 BNL consolidated operations to facilitate the demolition of 37,294 ft² of inefficient building space formally containing lead and asbestos materials. Also, some laboratories in

Buildings 463, 480, 490, 510, and 815 were renovated. These renovations resulted in the elimination of hazardous materials such as lead, asbestos, and radiological contamination, while offering the opportunity to install energy-efficient fixtures; lighting; heating, ventilation and air conditioning systems; and fume hoods.

2.4 IMPLEMENTING THE ENVIRONMENTAL MANAGEMENT SYSTEM

2.4.1 Structure and Responsibility

All employees at BNL have clearly defined roles and responsibilities in key areas, including environmental protection. Employees are required to develop a Roles, Responsibilities, Accountabilities, and Authorities document signed by the employee, his or her supervisor, and the supervisor's manager. BSA has clearly defined expectations for staff and management to be defined in this document. Under the BSA performance-based management model, senior management must communicate their expectation that all line managers and staff take full responsibility for their actions and be held accountable for environmental, safety, and health performance. Environmental and waste management technical support personnel assist the line organizations with identifying and carrying out their environmental responsibilities. The Environmental Compliance Representative Program, initiated in 1998, is an effective means of integrating environmental planning and pollution prevention into the work planning processes of the line organizations. A comprehensive training program for staff, visiting scientists, and contractor personnel is also in place, thus ensuring that all personnel are aware of their environmental, safety, and health responsibilities.

2.4.2 Communication and Community Involvement

A goal of BNL's EMS is to ensure commitment to communications and community outreach. Through this commitment, the Laboratory continues to develop and maintain positive, proactive, and constructive relationships with its employees, regulators, and the

community; promote open and honest communication on environmental performance; and actively seek and consider input from stakeholders. To help build these relationships, Laboratory staff regularly participate in on- and off-site meetings with regulators, elected and appointed officials, legislative committees, employees, and community members to discuss projects. Presentations, roundtables, workshops, canvassing, on-site tours, and official public comment periods all help to ensure input is gathered so that issues important to stakeholders are addressed and the values of the community are considered.

Several forums for communication have been established to facilitate dialogue with key stakeholders. The Brookhaven Executive Roundtable, established by DOE in 1997, meets bimonthly and enables BNL and DOE representatives to update staff from the offices of local, state, and federal elected officials and regulatory agencies on the Laboratory's operational issues, environmental issues, and science initiatives. The Community Advisory Council (CAC), established in 1998, provides input to the Director of the Laboratory on issues of importance to the community, including environmental stewardship and remediation activities. Members consist of representatives from many stakeholder groups, including civic, health, environmental, union, business, education, and employee organizations. The CAC meets monthly in sessions open to the public, and sets its own agenda in cooperation with the Laboratory.

Communication with employees helps ensure that staff is knowledgeable of the Laboratory's environmental policy, how their work can impact the environment, and what can be done to prevent such impacts. BNL encourages information flow from management to employees, and back up to management, recognizing that employees are an excellent source of information, issues, and ideas. Employees and retirees regularly interact with their neighbors and community groups, acting as the Laboratory's envoys. They provide information about Laboratory science, gather feedback, and respond to concerns.

In 2004, significant progress was made to advance several large proposed cleanup projects,

that have been of significant importance to BNL stakeholders:

- In May 2004, DOE and BNL solicited public comment regarding the cleanup of affected portions of the Peconic River, both on and off site, to be sure that decisions made were considerate of community expectations and protective of human health and the environment. The preferred recommendation was that 6 to 12 inches of sediment be removed from areas where contaminants had been deposited by outmoded historic disposal methods. Sediment would also be removed from areas identified as "preferential" sources of methylmercury, the form of organic mercury found in the environment that accumulates in fish and human tissue. Since part of the off-site area targeted for cleanup is located within Suffolk County parkland, the plan set more stringent cleanup goals for that area, giving the county the greatest flexibility for future use of the property. The \$11.5 million project is expected to result in an estimated 92 percent reduction of mercury and 93 percent removal of PCBs in on- and off-site river sediment. Other co-located contaminants will also be removed. The plan includes habitat restoration and long-term monitoring of surface water, sediment, and fish to evaluate the effectiveness of the cleanup.
- In August 2004, a draft plan for cleanup of the Brookhaven Graphite Research Reactor (BGRR) was submitted to the community for comment. The preferred recommendation called for the removal of the reactor pile and biological shield, accessible pockets of contaminated soil, and the fuel canal structure. It also called for the completion of actions that are currently underway or planned for this facility, followed by long-term response actions, including water-infiltration management, surveillance and maintenance, and institutional controls. The plan would result in the removal of more than 99 percent of the radionuclides found within the BGRR complex.

- In December 2004, DOE sought public comment on plans to remove chemical solvents from portions of the Magothy aquifer just south of the Laboratory that have been impacted by past operations on site. The recommendation was to operate groundwater extraction wells for approximately 10 years to capture high concentrations of chemicals and prevent additional contamination from entering the Magothy aquifer. The cleanup plan also called for 55 years of continued monitoring to ensure the proposed remedy is working. The plan addressed Sr-90 groundwater contamination on site, and called for 10 years of active treatment, followed by up to 70 years of monitoring and data analysis, to ensure that the cleanup is working and that contamination does not reach the site boundary.

Once DOE reviews the public comments, final decisions for each of these cleanup remedies will be made. The final decisions will be documented in Records of Decisions that are expected to be finalized in 2005. The Laboratory worked closely with EPA Region II, NYSDEC, New York State Department of Health (NYSDOH), and Suffolk County Department of Health Services (SCDHS) to resolve issues on plans, priorities, and corrective actions. The CAC also provided input regarding each of the plans. These discussions led to the development of the draft cleanup plans listed above.

Also in 2004, the CAC and BNL co-sponsored a free, one-day workshop on fleet-maintenance pollution-prevention techniques, capitalizing on the work the Laboratory has done in this area. More than 50 participants attended from a variety of institutions, including the towns of Brookhaven, Huntington, Oyster Bay, and Southold; Northrop Grumman Corporation; Suffolk County Water Authority; and United Parcel Service. Workshop speakers included BNL experts as well as guest speakers from NYSDEC and KeySpan. Alternative-fuel vehicles, vegetable-based hydraulic fluids, and re-refined motor oil were a few of the technologies discussed that the Laboratory uses to

protect the environment while reducing waste disposal costs through pollution prevention.

The Laboratory maintains an informative website at <http://www.bnl.gov>; issues press releases and e-mail updates; and publishes *discover Brookhaven* (the Laboratory's science magazine), *the Bulletin* (a weekly employee newsletter), and *Laboratory Link* (a monthly brief on research activities) to keep the public and employees informed about the Laboratory's research, activities, and issues, including those related to the environment. Employees and the community may subscribe to BNL's e-mail update service at <http://lists.bnl.gov/mailman/listinfo/bnl-announce-l>, which is a listing of all public mailing lists available at the Laboratory.

In 2004, BNL celebrated Earth Day with a variety of employee and community activities, including environmental stewardship awards, a student art contest involving children from local elementary schools, and a 4-mile running race. The Laboratory also participated with other local organizations and businesses in the two-day Heckscher State Park Spring Festival, using interactive displays to promote environmental awareness. BSA contributed corporate funds in support of these events as part of their commitment to environmental stewardship.

Also in 2004, the Laboratory hosted more than 30,600 visitors to the site, including students, teachers, and other community members who participated in "Summer Sunday" open houses, science-museum visits, site tours, and other outreach programs.

These are just some of the highlights of the many achievements and advances made within the BNL's environmental management program during 2004. These achievements and advances were the result of the commitment to excellence in Laboratory operations made by BNL management, employees, and many other stakeholders.

2.4.3 Monitoring and Measurement

Effluents and emissions are monitored to ensure the effectiveness of controls, adherence to regulatory requirements, and timely identification and implementation of corrective measures. BNL's Environmental Monitoring Program is a comprehensive, sitewide program that: identi-

fies potential pathways for exposure of the public and employees; evaluates what impact BNL activities have on the environment; and ensures compliance with environmental permit requirements. The monitoring program is reviewed and revised, as necessary or on an annual basis, to reflect changes in permit requirements, changes in facility-specific monitoring activities, or the need to increase or decrease monitoring based on a review of previous analytical results.

As required under DOE Order 450.1, *Environmental Protection Program*, BNL prepares an *Environmental Monitoring Plan, Triennial Update* (BNL 2003e), which outlines annual sampling goals by media and frequency. The plan uses the EPA Data Quality Objective approach for rationalizing the decisions associated with the monitoring program. In addition to the required triennial update, EWMSD prepares an electronic update each year.

In 2004, there were 8,031 sampling events of groundwater, potable water, precipitation, air, plants and animals, soil, sediment, and discharges under the Environmental Monitoring Program, as shown in Table 2-5. Specific sampling programs for the various media are described further in Chapters 3 through 8 and SER Volume II, *Groundwater Status Report*.

There are three components to the Environmental Monitoring Program: compliance, restoration, and surveillance monitoring, as described below.

2.4.3.1 Compliance Monitoring

Compliance monitoring is conducted to ensure that wastewater effluents, air emissions, and groundwater monitoring data comply with regulatory and permit limits issued under the federal Clean Air Act, Clean Water Act, Oil Pollution Act, Safe Drinking Water Act, and the New York State equivalents. Included in compliance monitoring are the following:

- *Air emissions monitoring* is conducted at reactors, accelerators, and other radiological emission sources, as well as the CSF. Real-time, continuous emission monitoring equipment is installed and maintained at some of these facilities, as required by permits and other regulations. At other fa-

cilities, samples are collected and analyzed periodically to ensure compliance with regulatory requirements. Analytical data are routinely reported to the permitting authority. See Chapters 3 and 4 for details.

- *Wastewater discharge monitoring* is performed at the point of discharge to ensure that the effluent complies with release limits in BNL's SPDES permits. Twenty-four point-source discharges are monitored under the BNL program: 12 under the ER Program and 12 under the SPDES permit. As required by permit conditions, samples are collected daily, weekly, monthly, or quarterly and monitored for organic, inorganic, or radiological parameters. Monthly reports that provide analytical results and an assessment of compliance for that reporting period are filed with the permitting agency. See Chapter 3, Section 3.6 for details.
- *Groundwater monitoring* is also performed in accordance with permit requirements. Specifically, monitoring of groundwater is required under the Major Petroleum Facility License for the CSF and the RCRA permit for the WMF. Extensive groundwater monitoring is also conducted under the ER Program, as required under the Records of Decision for many of the OUs or Areas of Concern (see Chapter 7 and Volume II of the SER, *Groundwater Status Report*, for details). Additionally, to ensure that the Laboratory maintains a viable potable water supply, groundwater is monitored as required by SCDHS.

2.4.3.2 Restoration Monitoring

Restoration monitoring is performed to determine the overall impact of past operations, to delineate the real extent of contamination, and to ensure that Removal Actions are effective and that remedial systems are performing as designed under CERCLA and RCRA.

This program typically involves collecting soil and groundwater samples to determine the lateral and vertical extent of the contaminated area. Samples are analyzed for organic,

Table 2-5. Summary of BNL 2004 Sampling Program Sorted by Media.

Environmental Media	No. of Sampling Events*	Purpose
Groundwater	1,889 ER 318 ES/C	Groundwater is monitored to evaluate impacts from past and present operations on groundwater quality, under the Environmental Restoration (ER), Environmental Surveillance (ES), and Compliance (C) sampling programs. See Chapter 7 and SER Volume II.
On-Site Recharge Basins	78	Recharge basins used for wastewater and stormwater disposal are monitored in accordance with discharge permit requirements and for environmental surveillance purposes. See discussion in Chapter 5.
Potable Water	38 ES 158 C	Potable water wells and the BNL distribution system are monitored routinely for chemical and radiological parameters to ensure compliance with Safe Drinking Water Act requirements. In addition, samples are collected under the Environmental Surveillance Program to ensure the source of the Laboratory's potable water is not impacted by contamination. See discussion in Chapters 3 and 7.
Sewage Treatment Plant (STP)	426	The STP influent and effluent and several upstream and downstream Peconic River stations are monitored routinely for organic, inorganic, and radiological parameters to assess BNL impacts. The number of samples taken depends on flow. For example, samples are scheduled for collection at Station HQ monthly, but if there is no flow, no sample can be collected. See discussion in Chapters 3 and 5.
Precipitation	8	Precipitation samples are collected from two locations to determine if radioactive emissions have impacted rainfall, and to monitor worldwide fallout from nuclear testing. The data are also used, along with wind speed, wind direction, temperature, and atmospheric stability to help model atmospheric transport and diffusion of radionuclides. See discussion in Chapter 4.
Air – Tritium Filters	262	Silica gel cartridges are used to collect atmospheric moisture for subsequent tritium analysis. These data are used to assess environmental tritium levels. Due to several years of nondetectable measurements and the shutdown of the High Flux Beam Reactor (HFBR), monitoring was reduced from weekly to once per month in several areas of the site in 1999. See discussion in Chapter 4.
Air – Particulate Filters	470 ES/C 53 NYSDOH	Samples are collected to assess impacts from BNL operations and to facilitate reporting of emissions to regulatory agencies. Samples are also collected for the New York State Department of Health Services (NYSDOH) as part of their program to assess radiological air concentrations statewide. See discussion in Chapter 4.
Air – Charcoal	64	Samples are collected to assess impacts from BNL operations and to facilitate reporting of emissions to regulatory agencies. See discussion in Chapter 4.
Fauna	102	Fish, deer, and small mammals are monitored to assess impacts on wildlife associated with past or current BNL operations. See discussion in Chapter 6.
Flora	9	Vegetation is sampled to assess possible uptake of contaminants by plants and fauna, since the primary pathway from soil contamination to fauna is via ingestion. See discussion in Chapter 6.
Soils	114	Soil samples are collected as part of the Natural Resource Management Program to assess faunal uptake, during Environmental Restoration investigative work, during the closure of drywells and underground tanks, and as part of preconstruction background sampling.
Miscellaneous	470	Samples are collected periodically from potable water fixtures and dispensers, manholes, and spills, to assess process waters and to assess sanitary discharges.
Groundwater Treatment Systems and Remediation Monitoring	1,318	Samples are collected from groundwater treatment systems and as long-term monitoring after remediation completion under the Comprehensive Environmental Response, Compensation, and Liability Act Program. The Laboratory had 12 operating groundwater treatment systems in 2004. See discussion in Chapter 7.
Vehicle Monitor Checks	250	Materials leaving the Laboratory pass through the on-site vehicle monitor that detects if radioactive materials are present. Any radioactive material discovered is properly disposed of through the Waste Management Program. The vehicle monitor is checked on a daily basis.
State Pollutant Discharge Elimination System (SPDES)	218	Samples are collected to ensure that the Laboratory complies with the requirements of the New York State Department of Environmental Conservation (NYSDEC)-issued SPDES permit. Samples are collected at the STP, recharge basins, and four process discharge sub outfalls to the STP.
Flow Charts	577	Flowcharts are exchanged weekly as part of the Laboratory's SPDES permit requirements to report discharge flow at the recharge basin outfalls.
Floating Petroleum Checks	104	This test is performed on select petroleum storage facility monitoring wells to determine if floating petroleum products are present. The number of wells and frequency of this testing is determined by NYSDC licensing requirements (e.g., Major Petroleum Facility), NYSDC spill response requirements (e.g., Motor Pool area), or other facility-specific sampling and analysis plans.

(continued on next page)

Table 2-5. Summary of BNL 2004 Sampling Program Sorted by Media (concluded).

Environmental Media	No. of Sampling Events*	Purpose
Radiological Monitor Checks	732	Daily instrumentation checks are conducted on the radiation monitors located in Buildings 569 and 592. These monitors are located 30 minutes upstream and at the STP. Monitoring at these locations allows for diversion of wastes containing radionuclides before they are discharged to the Peconic River.
QA/QC samples	373	To ensure that the concentrations of contaminants reported in the Site Environmental Report are accurate, additional samples are collected. These samples detect if contaminants are introduced during sampling, transportation, or analysis. Quality Assurance/Quality Control (QA/QC) samples are also sent to the contracted analytical laboratories to ensure their processes give valid, reproducible results.
Total number of sampling events	8,031	This number includes all the samples identified in the <i>Environmental Monitoring Plan</i> (BNL 2004), as well as samples collected to monitor Environmental Restoration projects and air and water treatment system processes and by the Environmental and Waste Management Services Division Field Sampling Team as special requests. The number does not include samples taken by Waste Management personnel, waste generators, or Environmental Compliance Representatives for waste characterization purposes.

Note:

* A sampling event is the collection of samples from a single georeferenced location. Multiple samples for different analyses (i.e., tritium, gross alpha, gross beta, VOCs) can be collected during a single sample event.

inorganic, and radiological contaminants, and the analytical results are compared with guidance, standards, cleanup goals, or background concentrations. Areas where impacts have been confirmed are fully characterized and, if necessary, remediated to mitigate continuing impacts. Followup monitoring of groundwater is conducted in accordance with a Record of Decision with regulatory agencies.

2.4.3.3 Surveillance Monitoring

Pursuant to DOE Order 450.1, surveillance monitoring is performed in addition to compliance monitoring, to assess potential environmental impacts that could result from routine facility operations. The BNL Surveillance Monitoring Program involves collecting samples of ambient air, surface water, groundwater, flora, fauna, and precipitation. Samples are analyzed for organic, inorganic, and radiological contaminants. Additionally, data collected using thermoluminescent dosimeters (devices to measure radiation exposure) strategically positioned on and off site are routinely reviewed under this program. Control samples (also called background or reference samples) also are collected on and off site to compare BNL results to areas that could not have been affected by BNL operations.

The monitoring programs can be broken down further by the relevant law or requirement (e.g.,

Clean Air Act) and even further by specific environmental media and type of analysis. The results of monitoring and the analysis of the monitoring data are the subject of the remaining chapters of this report. Chapter 3 summarizes environmental requirements and compliance data, Chapters 4 through 8 give details on media-specific monitoring data and analysis, and Chapter 9 provides supporting information for understanding and validating the data shown in this report. Groundwater restoration and surveillance data are discussed in detail in SER Volume II.

2.4.4 EMS Assessments

To periodically verify that the EMS is operating as intended, audits are conducted as part of BNL's Self-Assessment Program. The audits are designed to ensure that any nonconformance to the ISO 14001 Standard is identified and addressed. In addition, compliance with regulatory requirements is verified through routine inspections, operational evaluations, and focused compliance audits. BNL's Self-Assessment Program consists of several processes, as described below.

- *Self-assessment* is the systematic evaluation of internal processes and performance. The approach for the environmental self-assessment program includes evaluating programs and pro-

cesses within organizations that have environmental aspects. Conformance to the Laboratory's EMS requirements is verified, progress toward achieving environmental objectives is monitored, operations are inspected to verify compliance with regulatory requirements, and the overall effectiveness of the EMS is evaluated. Environmental experts routinely participate in these assessments. BNL management conducts assessments to evaluate Laboratory environmental performance from a programmatic perspective, to determine if there are Laboratory-wide issues that require attention, and to facilitate the identification and communication of "best management" practices used in one part of the Laboratory that could improve performance in other parts. BNL management also routinely evaluates progress on key environmental improvement projects. The Laboratory and DOE periodically perform assessments to facilitate the efficiency of assessment activities and ensure that the approach to performing the assessments meets DOE expectations.

- *Independent assessments* are performed by staff that do not have line responsibility for the work processes involved. These assessments verify the effectiveness and adequacy of management processes (including self-assessment programs) at the division, department, directorate, and Laboratory levels. Special investigations are also conducted to identify the root causes of problems, as well as corrective actions and lessons learned.

The Laboratory's Self-Assessment Program is augmented by programmatic, external audits conducted by DOE. BSA staff and subcontractors also perform periodic independent reviews. An independent third party conducts ISO 14001 registration audits of BNL's EMS. BNL is also subject to extensive oversight by external regulatory agencies (see Chapter 3 for details). Results of all assessment activities related to environmental performance are included, as appropriate, throughout this report.

2.5 ENVIRONMENTAL STEWARDSHIP AT BNL

BNL has unprecedented knowledge of its potential environmental vulnerabilities and current operations due to programs such as the Facility Review Disposition Project, process evaluations, the work planning and control system, and the management systems for groundwater protection, environmental restoration, and information management. Compliance assurance programs have improved BNL's compliance status and pollution prevention projects have reduced costs, minimized waste generation, and reused and recycled significant quantities of materials.

The Laboratory is openly communicating with neighbors, regulators, employees, and other interested parties on issues and progress. To regain and maintain stakeholder trust, BNL will continue to deliver on commitments and demonstrate improvements in environmental performance. The Site Environmental Report is an important communication mechanism, as it summarizes BNL's environmental programs and performance each year. Additional information about BNL's environmental programs is available on BNL's website at <http://www.bnl.gov>. The Laboratory continues to pursue other mechanisms to communicate data in a more user friendly, visual, and timely manner.

The existing BNL EMS is viewed as exemplary within DOE. Due to external recognition of BNL's knowledge and unique experience implementing the EMS program, several DOE facilities and private universities have invited BNL to extend its outreach activities and share its experiences, lessons learned, and successes. BNL's environmental programs and projects have been recognized with national and regional awards.

Audits have consistently observed a high level of management involvement, commitment, and support for environmental protection and the EMS. Audits and EMS management reviews have noted the following improvements made since BSA began managing the Laboratory:

- The EMS has been strengthened, integrated with other BNL management systems, and formalized.

- Line ownership for environmental stewardship has been established, key roles and responsibilities have been identified and clarified, and expectations have been made explicit.
- A comprehensive environmental training program has been implemented.
- From the process evaluation project, BNL has improved its understanding of environmental aspects, waste streams, and applicable requirements.
- There is much greater formality with regard to control of EMS documents, manuals, and procedures. Procedures and requirements have been updated, and environmental management programs have been improved.
- BNL has been very successful in achieving environmental goals and critical outcomes. There have been successes in ISO 14001 Standard registration and recertification, compliance improvements (e.g., facility modifications, implementation of SBMS, enhanced operational controls), and increased environmental knowledge and awareness on the part of management, employees, contractors, and visitors.
- Communication on environmental issues has improved, occurs at the highest levels of management, and reporting is more formal. Managers are better informed about environmental aspects, issues, and performance.
- Core EMS teams representing many organizations have been formed. A consensus process is used to develop the system, improving acceptance and support.
- There has been strong implementation of the EMS throughout organizations, and cultural change has been notable.

For more than 50 years, the unique, leading-edge research facilities at BNL have made many in-

novative scientific contributions possible. Today, BNL continues its research mission while focusing on cleaning up and protecting the environment. The Laboratory's environmental motto, which was generated in an employee suggestion contest, is "Exploring Earth's Mysteries ... Protecting Its Future," and reflects BNL's desire to balance world-class research with environmentally responsible operations.

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Compliance Status

Brookhaven National Laboratory (BNL) is subject to more than 100 sets of federal, state, and local environmental regulations; numerous site-specific permits; equivalency permits for operation of twelve groundwater remediation systems; and several other binding agreements. In 2004, BNL operated in full compliance with most 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, however, minor deficiencies were noted during inspections conducted by the New York State Department of Environmental Conservation (NYSDEC).

Emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide were all within permit limits. Approximately 5,450 pounds of ozone-depleting refrigerants were shipped for recycling through the Department of Defense, and another 640 pounds were recovered and recycled on site. Monitoring of the BNL potable water system showed that 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. During 2004, liquid effluents discharged to surface water and groundwater met all applicable New York State Pollutant Discharge Elimination System permit requirements, with the exception of six excursions at the Sewage Treatment Plant. These permit excursions were reported to NYSDEC and the Suffolk County Department of Health Services.

Thirty reportable spills of petroleum products or antifreeze occurred on site in 2004. Nineteen were petroleum releases less than 5 gallons, four were small-volume antifreeze spills, two larger spills were discovered during tank removals, four spills resulted from failed equipment, and one spill was a release of oil from two transformers that were contaminated with polychlorinated biphenyls (PCBs). All releases were cleaned up or addressed to the satisfaction of NYSDEC.

BNL underwent twelve environmental audits by external regulatory agencies in 2004. These audits included inspections of petroleum and chemical storage, air emissions from the Central Steam Facility, Hazardous Waste management facilities, Sewage Treatment Plant operations, other regulated outfalls and recharge basins, and the potable water system. Immediate corrective actions were taken to address all issues raised during these inspections. NYSDEC conducted two reviews of the hazardous waste program in 2004, and Notices of Violation were issued for administrative deficiencies (primarily labeling issues).

3.1 COMPLIANCE WITH REQUIREMENTS

BNL is subject to more than 100 sets of federal, state, and local environmental regulations; several site-specific permits; 16 equivalency permits for the operation of 12 groundwater

remediation systems; and several other binding agreements. The federal, state, and local environmental statutes and regulations that BNL operates under are summarized in Table 3-1, along with a discussion of BNL's compliance status

with regard to each requirement. A complete listing of all applicable environmental regulations is contained in Appendix D.

3.2 ENVIRONMENTAL PERMITS

3.2.1 Existing Permits

Many processes and facilities at BNL operate under permits issued by environmental regulatory agencies. Table 3-2 provides a complete list of the existing permits, some of which are briefly described below.

- State Pollutant Discharge Elimination System (SPDES) permit, issued by NYSDEC
- Major Petroleum Facility (MPF) license, issued by NYSDEC
- Resource Conservation and Recovery Act (RCRA) permit issued by NYSDEC for the Waste Management Facility
- Registration certificate from NYSDEC for tanks storing bulk quantities of hazardous substances
- Seven radiological emission authorizations issued by EPA under the National Emission Standards for Hazardous Air Pollutants (NESHAPs)
- Air emissions permit issued by NYSDEC under Title V of the Clean Air Act Amendments authorizing the operation of 16 emissions units
- Four permits issued by NYSDEC for construction activities within the Peconic River corridor
- An EPA Underground Injection Control (UIC) Area permit for the operation of 90 UIC wells
- Permit for the operation of six domestic water supply wells, issued by NYSDEC
- Sixteen equivalency permits for the operation of 12 groundwater remediation systems installed under the Inter-Agency Agreement (Federal Facility Agreement under the Comprehensive Environmental Response, Compensation and Liability Act [CERCLA] 120, Administrative Docket No. II-CERCLA-FFA-00201)

3.2.2 New or Modified Permits and Requests

3.2.2.1 State Pollutant Discharge Permits

The SPDES permit authorizes discharges from the BNL Sewage Treatment Plant (STP) to the Peconic River, and discharges of cooling water and stormwater to recharge basins. In February 2004, NYSDEC approved the Laboratory's petition to allow filtration of stormwater runoff samples prior to acid preservation. Filtration reduces the contribution of metals (primarily aluminum and iron) from natural sediment and is more representative of BNL's discharges. Filtration was permitted since stormwater is discharged to recharge basins, which effectively filter out these particulates before the water recharges to groundwater. A second revision contained in the modified permit postponed chronic toxicity testing to 2005. The current SPDES permit expires in March 2005. Therefore, in accordance with New York State Uniform Procedures, a SPDES permit renewal request was filed in August 2004 (i.e., 180 days before the permit expiration date).

Discharges of treated groundwater under the CERCLA program are also permitted by NYSDEC through the issuance of SPDES equivalency permits. In 2004, four SPDES equivalency permits were issued, one each for treatment systems identified as North Street/ North Street East, LIPA/Airport, Ethylene Dibromide, and Industrial Park East.

SPDES equivalency permits are discussed in Volume II of the SER, *Groundwater Status Report*.

3.2.2.2 Air Emissions Permits

Air emissions permits are granted by NYSDEC. Permits are issued either as "equivalency" permits for restoration projects conducted under CERCLA, or as changes to the BNL Title V operating permit, which was issued in January 2002 and subsequently amended in November 2002. During 2004, no CERCLA equivalency permits were issued and no changes were made to the BNL Title V operating permit.

The Title V permit consolidates all applicable federal and state requirements for BNL's

regulated emission sources into a single document. BNL has a variety of nonradioactive air emission sources covered under the permit that are subject to federal or state regulations. Section 3.5 describes the more significant sources and the methods used by BNL to comply with the applicable regulatory requirements.

3.2.2.3 *Underground Injection Control (UIC) Permit*

Under the Safe Drinking Water Act (SDWA), BNL is required to maintain an Area Permit for UIC wells (e.g., drywells, cesspools, and leaching pools). BNL received a final permit in January 2001. This permit authorizes the operation of 90 UICs, including 86 stormwater drywells and four small sanitary systems. The only change to the UIC inventory in 2004 was the partial closure of a sanitary wastewater disposal system at Building 445. The remediation of contaminated sediments from this system continued into 2005. This device is expected to be closed in the spring of 2005. UICs also are

used for the disposal of treated groundwater at many restoration facilities. In 2004, the inventory on record with EPA was updated, bringing the total number of UICs used for restoration to 34. These devices are authorized by rule, as opposed to a permit, and an inventory of the devices is maintained with EPA.

3.3 NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA) regulations require federal agencies to evaluate the effects of proposed major federal activities on the environment. The prescribed evaluation process ensures that the proper level of environmental review is performed before an irreversible commitment of resources is made. During 2004, environmental evaluations were completed for 127 proposed projects. Of these projects, 111 were considered minor actions requiring no additional documentation. The remaining 16 projects were addressed through the submission of Environmental Evaluation Notification Forms

Table 3-1. Federal, State, and Local Environmental Statutes and Regulations Applicable to BNL.

Regulator: Codified Regulation	Regulatory Program Description	Compliance Status	SER Report Sections
EPA: 40 CFR 300 40 CFR 302 40 CFR 355 40 CFR 370	The Comprehensive Environmental Response, Compensation & Liability Act (CERCLA) provides the regulatory framework for remediation of releases of hazardous substances and remediation of inactive hazardous waste disposal sites.	In 1989, BNL entered into a tri-party agreement with EPA, New York State Department of Environmental Conservation (NYSDEC), and DOE. BNL site remediation is conducted by the Environmental Restoration Program in accordance with milestones established under this agreement.	2.3.4.8
Council for Env. Quality: 40 CFR 1500–1508 DOE: 10 CFR 1021	The National Environmental Policy Act (NEPA) requires federal agencies to follow a prescribed process to anticipate the impacts on the environment of proposed major federal actions and alternatives. DOE codified its implementation of NEPA in 10 CFR 1021.	BNL is in full compliance with NEPA requirements. The Laboratory has established sitewide procedures for implementing the NEPA requirements.	3.3
Advisory Council on Historic Preservation: 36 CFR 60 36 CFR 63 36 CFR 79 36 CFR 800 16 USC 470	The National Historic Preservation Act (NHPA) identifies, evaluates, and protects historic properties eligible for listing in the National Register of Historic Places, commonly known as the National Register. Such properties can be archeological sites or historic structures, documents, records, or objects. NHPA is administered by state historic preservation offices (SHPOs). In New York, that is the NYSHPO. At BNL, structures that may be subject to NHPA include the High Flux Beam Reactor (HFBR), the Brookhaven Graphite Research Reactor (BGRR) complex, World War I training trenches near the Relativistic Heavy Ion Collider project, and the former Cosmotron Building.	The HFBR, BGRR complex, and World War I trenches are eligible for inclusion in the National Register. The former Cosmotron Building was identified as potentially eligible in an April 1991 letter from NYSHPO. Any proposed activities involving these facilities must be identified through the NEPA process and evaluated to determine if the action would affect the features that make the facility eligible. Some actions required for decontaminating and decommissioning the BGRR were determined to affect its eligibility, and mitigative actions are proceeding according to a Memorandum of Agreement between DOE and NYSHPO. BNL has a Cultural Resource Management Plan to ensure compliance with cultural resource regulations.	3.4

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CHAPTER 3: COMPLIANCE STATUS

Table 3-1. Federal, State, and Local Environmental Statutes and Regulations Applicable to BNL *(continued)*.

Regulator: Codified Regulation	Regulatory Program Description	Compliance Status	SER Report Sections
EPA: 40 CFR 50-0 40 CFR 82 NYSDEC: 6 NYCRR 200–257* 6 NYCRR 307	The Clean Air Act (CAA) and the NY State Environmental Conservation Laws regulate the release of air pollutants through permits and air quality limits. Emissions of radionuclides are regulated by EPA, via the National Emission Standards for Hazardous Air Pollutants (NESHAPs) authorizations.	All air emission sources are incorporated into the BNL Title V permit or have been exempted under the New York State air program.	3.5
EPA: 40 CFR 109–140* 40 CFR 230, 231 40 CFR 401, 403 NYSDEC: 6 NYCRR 700–703 6 NYCRR 750	The Clean Water Act (CWA) and NY State Environmental Conservation Laws seek to improve surface water quality by establishing standards and a system of permits. Wastewater discharges are regulated by NYSDEC permits through the State Pollutant Discharge Elimination System (SPDES).	At BNL, permitted discharges include treated sanitary waste, and cooling tower and stormwater discharges. With the exception of six excursions, these discharges met the SPDES permit limits in 2004.	3.6
EPA: 40 CFR 141–149 NYSDOH: 10 NYCRR 5	The Safe Drinking Water Act (SDWA) and New York State Department of Health (NYSDOH) standards for public water supplies establish minimum drinking water standards and monitoring requirements. SDWA requirements are enforced by the Suffolk County Department of Health Services (SCDHS).	BNL maintains a sitewide public water supply. This water supply met all primary drinking water standards as well as operational and maintenance requirements.	3.7
EPA: 40 CFR 112 40 CFR 300 40 CFR 302 40 CFR 355 40 CFR 370 40 CFR 372	The Oil Pollution Act, the Emergency Planning & Community Right-to-Know Act (EPCRA), and the Superfund Amendment Reauthorization Act (SARA) require facilities with large quantities of petroleum products or chemicals to prepare emergency plans and report their inventories to EPA, the state, and local emergency planning groups.	Since some facilities at BNL store or use chemicals or petroleum in quantities exceeding threshold planning quantities, BNL is subject to these requirements. BNL fully complies with all reporting and emergency planning requirements.	3.8.1 3.8.2 3.8.3
EPA: 40 CFR 280 NYSDEC: 6 NYCRR 595–597 6 NYCRR 611–613 SCDHS: SCSC Article 12	Federal, state, and local regulations govern the storage of chemicals and petroleum products to prevent releases of these materials to the environment. SCDHS has safety codes that are more stringent than the federal and state regulations	The regulations require that these materials be managed in facilities equipped with secondary containment, overfill protection, and leak detection. BNL complies with all federal and state requirements and has achieved conformance to county codes.	3.8.4 3.8.5 3.8.6
EPA: 40 CFR 260–280* NYSDEC: 6 NYCRR 360–372*	The Resource Conservation Recovery Act (RCRA) and New York State Solid Waste Disposal Act govern the generation, storage, handling, and disposal of hazardous wastes.	BNL is defined as a large-quantity generator of hazardous waste and has a permitted waste management facility. While almost all wastes are handled and disposed in accordance with federal and state requirements, two NYSDEC audits conducted in 2004 identified several concerns. These were immediately addressed by corrective actions.	3.9
EPA: 40 CFR 700–763*	The Toxic Substances Control Act (TSCA) regulates the manufacture, use, and distribution of all chemicals.	BNL manages all TSCA-regulated materials, including PCBs, in compliance with all requirements.	3.10
EPA: 40 CFR 162–171(f) NYSDEC: 6 NYCRR 320 6 NYCRR 325–329	The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and corresponding NY State regulations govern the manufacture, use, storage, and disposal of pesticides and herbicides, as well as the pesticide containers and residuals.	BNL employs NY State-certified pesticide applicators to apply pesticides and herbicides. Each applicator attends training as needed to maintain current certification, and files an annual report to the State detailing the types and quantity of pesticides applied.	3.11

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Table 3-1. Federal, State, and Local Environmental Statutes and Regulations Applicable to BNL (*continued*).

Regulator: Codified Regulation	Regulatory Program Description	Compliance Status	SER Report Sections
DOE: 10 CFR 1022 NYSDEC: 6 NYCRR 663 6 NYCRR 666	DOE regulations require its facilities to comply with floodplain/wetland review requirements. The New York State Fresh Water Wetlands and Wild, Scenic, and Recreational Rivers rules govern development in the state's natural waterways. Development or projects within a half-mile of regulated waters must have NYSDEC permits.	BNL is in the Peconic River watershed and has several jurisdictional wetlands; consequently, development of locations in the north and east of the site requires NYSDEC permits and review for compliance under DOE wetland/floodplain regulations. During 2004, four projects were permitted under New York State programs.	3.12
U.S. Fish & Wildlife Service: 50 CFR 17 NYSDEC: 6 NYCRR 182	The Endangered Species Act and corresponding New York State regulations prohibit activities that would jeopardize the continued existence of an endangered or threatened species, or cause adverse modification to a critical habitat.	Eight additional species on the NYS list have been found at BNL, for a total of 38. In the "endangered" category are one insect, one amphibian, and one plant. In the "threatened" category are one insect, two fish, one bird, and two plants. Of "special concern" are one insect, two amphibians, four reptiles, and five birds. The remaining 16 species are vulnerable or rare plants. BNL's <i>Natural Resource Management Plan</i> outlines activities to protect species and protect their habitats.	3.13
DOE: Manual 231.1-1A	The Environment, Safety, and Health Reporting Program objective is to ensure timely collection, reporting, analysis, and dissemination of information on environment, safety, and health issues as required by law or regulations or as needed to ensure that DOE is kept fully informed on a timely basis about events that could adversely affect the health and safety of the public, workers, the environment, the intended purpose of DOE facilities, or the credibility of the DOE. Included in the order are the requirements for the Occurrence Reporting and Processing of Operations Program, known as ORPS.	BNL prepares an annual Site Environmental Report and provides data for DOE to prepare annual NEPA summaries and other Safety, Fire Protection, and OSHA reports. BNL developed the ORPS subject area for staff and management who perform specific duties related to discovery, response, notification, investigation, and reporting of occurrences to BNL and DOE management. The ORPS subject area is supported by these additional documents: Occurrence Reporting Program Description, Critiques subject area, Occurrence Categorizer's Procedure, and the ORPS Office Procedure.	All chapters
DOE: Order 414.1 10 CFR 830, Subpart A Policy 450.5	The Quality Assurance (QA) Program objective is to establish an effective management system using the performance requirements of this Order, coupled with technical standards, where appropriate, to ensure: senior management provides planning, organization, direction, control, and support to achieve DOE objectives; line organizations achieve and maintain quality while minimizing safety and health risks and environmental impacts and maximizing reliability and performance; line organizations have a basic management system in place supporting this Order; and each DOE element reviews, evaluates, and improves its overall performance and that of its contractors using a rigorous assessment process based on an approved QA Program.	BNL has a Quality Management (QM) System to implement quality management methodology throughout its management systems and associated processes to: 1) plan and perform Laboratory operations reliably and effectively to minimize the impact on the safety and health of humans and on the environment; 2) standardize processes and support continuous improvement in all aspects of Laboratory operations; and 3) enable the delivery of products and services that meet customers' requirements and expectations. Having a comprehensive program ensures that all environmental monitoring data meet QA and quality control requirements. Samples are collected and analyzed using standard operating procedures, to ensure representative samples and reliable, defensible data. Quality control in the analytical labs is maintained through daily instrument calibration, efficiency and background checks, and testing for precision and accuracy. Data are verified and validated according to project-specific quality objectives before they are used to support decision making.	Chapter 9
DOE: Order 435.1	The Radioactive Waste Management Program objective is to ensure that all DOE radioactive waste is managed in a manner that protects workers, public health and safety, and the environment. DOE Order 435.1 requires all DOE organizations that generate radioactive waste to implement a waste certification program. DOE Laboratories must develop a Radioactive Waste Management Basis (RWMB) Program Description, which includes exemption and timeframe requirements for staging and storing radioactive wastes, both routine and nonroutine.	The BNL Waste Certification Program Plan (WCPP) in the RWMB Program Description defines the radioactive waste management program's structure, logic, and methodology for waste certification. New or modified operations or activities that do not fall within the scope of the RWMB Program Description must be documented and approved before implementation. BNL's RWMB Program Description describes the BNL policies, procedures, plans, and controls demonstrating that BNL has the management systems, administrative controls, and physical controls to comply with DOE Order 435.1.	2.3.4.3

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Table 3-1. Federal, State, and Local Environmental Statutes and Regulations Applicable to BNL (concluded).

Regulator: Codified Regulation	Regulatory Program Description	Compliance Status	SER Report Sections
DOE: Order 450.1 (former Order 5400.1)	The Environmental Protection Program objective is to implement sound stewardship practices that protect the air, water, land, and other natural and cultural resources affected by DOE operations in a cost-effective manner, meeting or exceeding applicable environmental, public health, and resource protection laws and regulations, and DOE requirements. DOE facilities meet this objective by implementing an Environmental Management System (EMS) that is part of an Integrated Safety Management System (ISMS). Other components include establishing sound environmental monitoring programs to comply with former DOE Order 5400.1.	BNL's EMS was officially registered to the ISO 14001:1996 Standard in 2001. Annual audits to maintain certification were done in 2002 and 2003. In June 2004, a recertification audit was conducted and BNL was found to conform to the ISO 14001: 2004 Standard. The BNL ISMS program description presents the Laboratory's approach to integrating environment, safety, and health requirements into the processes for planning and conducting work at BNL. It describes BNL's programs, including the Standards-Based Management System (SBMS), for accomplishing work safely and provides a road map of the systems and processes.	Chapter 2
DOE: Order 5400.5, Change 2	To protect members of the public and the environment against undue risk from radiation, the Radiation Protection of the Public and Environment Program establishes standards and requirements for operations of DOE and DOE contractors.	BNL uses the guidance values provided in DOE Order 5400.5 to ensure that effluents and emissions do not affect the environment or public and worker safety and health, and to ensure that all doses meet the "As Low As Reasonably Achievable" (ALARA) policy.	Chapters 4, 5, 6, and 8

Notes:

CFR = Code of Federal Regulations

NYCRR = New York Codes, Rules, and Regulations

SCSC = Suffolk County Sanitary Code

to DOE. Evaluation of these projects resulted in the determination by DOE that they were either covered by existing Categorical Exclusions, as defined in Volume 10 of the Code of Federal Regulations, Section 1021 (referred to as 10 CFR 1021), or fell within the scope of a previous environmental assessment. Therefore, new environmental assessments were not required.

3.4 HISTORIC PRESERVATION AND ARCHEOLOGY

BNL is subject to several cultural resource laws, most notably the National Historic Preservation Act (NHPA) and the Archeological Resource Protection Act (ARPA). These acts require federal agencies to identify, evaluate, and consider the effects of federal actions on historical and archeological sites eligible for listing or inclusion on the National Register of Historic Places. The sites may include historic structures, objects, documents, and cultural or natural places that have importance to Native Americans or other ethnic groups.

BNL has three structures or sites that have been determined to be eligible for listing on the National Register of Historic Places:

the Brookhaven Graphite Research Reactor (BGRR) complex, the High Flux Beam Reactor (HFBR) complex, and the World War I Army training trenches associated with Camp Upton. In 2004, BNL submitted NHPA Section 106 packages to the New York State Historic Preservation Officer documenting the determination that two WW II-era buildings, slated for demolition, were not eligible for listing on the National Register of Historic Places. Those structures are Building 193, the Credit Union/Bank, and Building 527, used for offices.

The annual Department of Interior questionnaire regarding historic and cultural resources was completed and submitted as required. Additional activities in 2004 associated with NHPA and ARPA compliance are identified in Chapter 6, Section 6.9, Cultural Resource Activities.

3.5 CLEAN AIR ACT

The objectives of the Clean Air Act (CAA), which is administered by EPA and NYSDEC, are to improve or maintain regional ambient air quality through operational and engineering controls on stationary or mobile sources of air

Table 3-2. BNL Environmental Permits.

Issuing Agency	Bldg or Facility	Process/Permit Description	Permit ID No.	Expiration or Completion	Emission Unit ID	Source ID
EPA - NESHAPs	510	Calorimeter Enclosure	BNL-689-01	None	NA	NA
EPA - NESHAPs	705	Building Ventilation	BNL-288-01	None	NA	NA
EPA - NESHAPs	820	Accelerator Test Facility	BNL-589-01	None	NA	NA
EPA - NESHAPs	AGS	AGS Booster - Accelerator	BNL-188-01	None	NA	NA
EPA - NESHAPs	RHIC	Accelerator	BNL-389-01	None	NA	NA
EPA - SDWA	BNL	Underground Injection Control	NYU500001	11-Feb-11	NA	NA
NYSDEC - Air Equivalency	517	Middle Road System	1-51-009	NA	NA	NA
NYSDEC - Air Equivalency	518	South Boundary System	1-51-009	NA	NA	NA
NYSDEC - Air Equivalency	598	OU I Remediation System	1-52-009	NA	NA	NA
NYSDEC - Air Equivalency	539	Western South Boundary System	1-52-009	NA	NA	NA
NYSDEC - Air Equivalency	TR 867	T-96 Remediation System	NA	NA	NA	NA
NYSDEC - SPDES Equivalency	517	Middle Road System	1-51-009	NA	NA	NA
NYSDEC - SPDES Equivalency	518	South Boundary System	1-51-009	NA	NA	NA
NYSDEC - SPDES Equivalency	539	W. South Boundary System	1-52-009	NA	NA	NA
NYSDEC - SPDES Equivalency	598	OU I Remediation System	1-52-009	31-Oct-06	NA	NA
NYSDEC - SPDES Equivalency	598	Tritium Remediation System	1-52-009	NA	NA	NA
NYSDEC - SPDES Equivalency	670	Sr-90 Treatment System	None	NA	NA	NA
NYSDEC - SPDES Equivalency	TR 829	Carbon Tetrachloride System	None	NA	NA	NA
NYSDEC - SPDES Equivalency	OS-4	Airport/LIPA Treatment System	None	NA	NA	NA
NYSDEC - SPDES Equivalency	OS-2	Industrial Park East Treatment System	None	NA	NA	NA
NYSDEC - SPDES Equivalency	OS-5	North St./North St. East Treatment System	None	NA	NA	NA
NYSDEC - SPDES Equivalency	OS-6	Ethylene Di-Bromide Treatment System	None	NA	NA	NA
NYSDEC - Hazardous Substance	BNL	Bulk Storage Registration Certificate	1-000263	27-Jul-05	NA	NA
NYSDEC - LI Well Permit	BNL	Domestic Potable/Process Wells	1-4722-00032/00113	13-Sep-08	NA	NA
NYSDEC - Air Quality	197	Lithographic Printing Presses	1-4722-00032/00115	06-Jan-07	U-LITHO	19709-10
NYSDEC - Air Quality	423	Metal Parts Cleaning Tanks	1-4722-00032/00115	06-Jan-07	U-METAL	42306-08
NYSDEC - Air Quality	423	Gasoline Storage & Fuel Pumps	1-4722-00032/00115	06-Jan-07	U-FUELS	42309-10
NYSDEC - Air Quality	423	Motor Vehicle A/C Servicing	1-4722-00032/00115	06-Jan-07	U-MVACS	MVAC1&2
NYSDEC - Air Quality	458	Paint Spray Booth	1-4722-00032/00115	06-Jan-07	U-45801	45801
NYSDEC - Air Quality	458	Flammable Liquid Storage Cabinet	1-4722-00032/00115	06-Jan-07	U-45801	458AA
NYSDEC - Air Quality	473	Metal Parts Cleaning Tank	1-4722-00032/00115	06-Jan-07	U-METAL	47302
NYSDEC - Air Quality	479	Metal Parts Cleaning Tank	1-4722-00032/00115	06-Jan-07	U-METAL	47906
NYSDEC - Air Quality	490	Milling Machine/Block Cutter	1-4722-00032/00115	06-Jan-07	U-49003	49003
NYSDEC - Air Quality	490	Lead Alloy Melting	1-4722-00032/00115	06-Jan-07	U-49003	49004
NYSDEC - Air Quality	498	Aqueous Cleaning Facility	1-4722-00032/00115	06-Jan-07	U-METAL	49801
NYSDEC - Air Quality	535B	Plating Tanks	1-4722-00032/00115	06-Jan-07	U-INSIG	53501
NYSDEC - Air Quality	535B	Etching Machine	1-4722-00032/00115	06-Jan-07	U-INSIG	53502
NYSDEC - Air Quality	535B	Printed Circuit Board Process	1-4722-00032/00115	06-Jan-07	U-INSIG	53503
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	06-Jan-07	U-61005	61005
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	06-Jan-07	U-61006	61006
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	06-Jan-07	U-61007	61007
NYSDEC - Air Quality	610	Metal Parts Cleaning Tray	1-4722-00032/00115	06-Jan-07	U-METAL	61008

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Table 3-2. BNL Environmental Permits (concluded).

Issuing Agency	Bldg or Facility	Process/Permit Description	Permit ID No.	Expiration or Completion	Emission Unit ID	Source ID
NYSDEC - Air Quality	610	Combustion Unit	1-4722-00032/00115	06-Jan-07	U-61005	6101A
NYSDEC - Air Quality	630	Gasoline Storage and Fuel Pumps	1-4722-00032/00115	06-Jan-07	U-FUELS	63001-03
NYSDEC - Air Quality	820	Metal Parts Cleaning Tank	1-4722-00032/00115	06-Jan-07	U-METAL	82001
NYSDEC - Air Quality	902	Epoxy Coating/Curing Exhaust	1-4722-00032/00115	06-Jan-07	U-COILS	90206
NYSDEC - Air Quality	903	Metal Parts Cleaning Tank	1-4722-00032/00115	06-Jan-07	U-METAL	90304
NYSDEC - Air Quality	919B	Electroplating Operation	1-4722-00032/00115	06-Jan-07	U-INSIG	91904
NYSDEC - Air Quality	922	Metal Parts Cleaning Tank	1-4722-00032/00115	06-Jan-07	U-METAL	92202-03
NYSDEC - Air Quality	922	Electroplating Operation	1-4722-00032/00115	06-Jan-07	U-INSIG	92204
NYSDEC - Air Quality	923	Electronic Equipment Cleaning	1-4722-00032/00115	06-Jan-07	U-METAL	9231A
NYSDEC - Air Quality	923	Parts Drying Oven	1-4722-00032/00115	06-Jan-07	U-METAL	9231B
NYSDEC - Air Quality	924	Magnet Coil Production Press	1-4722-00032/00115	06-Jan-07	U-INSIG	92402
NYSDEC - Air Quality	924	Vapor/Ultrasonic Degreasing Unit	1-4722-00032/00115	06-Jan-07	U-METAL	92404
NYSDEC - Air Quality	Site	Halon 1211 Portable Extinguishers	1-4722-00032/00115	06-Jan-07	U-HALON	H1211
NYSDEC - Air Quality	Site	Halon 1301 Fire Suppression Systems	1-4722-00032/00115	06-Jan-07	U-HALON	H1301
NYSDEC - Air Quality	Site	Packaged A/C Units	1-4722-00032/00115	06-Jan-07	U-RFRIG	PKG01-02
NYSDEC - Air Quality	Site	Reciprocating Chillers	1-4722-00032/00115	06-Jan-07	U-RFRIG	REC01-41
NYSDEC - Air Quality	Site	Rotary Screw Chillers	1-4722-00032/00115	06-Jan-07	U-RFRIG	ROTO1-07
NYSDEC - Air Quality	Site	Split A/C Units	1-4722-00032/00115	06-Jan-07	U-RFRIG	SPL01-02
NYSDEC - Air Quality	Site	Centrifugal Chillers	1-4722-00032/00115	06-Jan-07	U-RFRIG	CEN01-22
NYSDEC - Hazardous Waste	WMF	Waste Management	1-4722-00032/00102	12-Jul-05	NA	NA
NYSDEC - Natural Resources	AGS	Construction of AGS Storage Facility	1-4722-00032/00133	03-Jun-06	NA	NA
NYSDEC - Natural Resources	RHIC	Construction of New Recharge Basin	1-4722-00032/00129	17-May-04	NA	NA
NYSDEC - Natural Resources	RHIC	Paving at Bldgs. 1002 and 1004	1-4722-00032/00135	09-Oct-08	NA	NA
NYSDEC - Natural Resources	RHIC	Construct 9C/7C Alcove Building	1-4722-00032/00137	08-Sep-08	NA	NA
NYSDEC - NESHAPs	REF	Radiation Effects/Neutral Beam	BNL-789-01	None	NA	NA
NYSDEC - NESHAPs	RTF	Radiation Therapy Facility	BNL-489-01	None	NA	NA
NYSDEC - Water Quality	CSF	Major Petroleum Facility	1-1700	31-Mar-07	NA	NA
NYSDEC - Water Quality	STP	Sewage Plant and Recharge Basins	NY-0005835	01-Mar-05	NA	NA

Notes:

AGS = Alternating Gradient Synchrotron

CSF = Central Steam Facility

ID = Identification

NESHAPs = National Emission Standards for Hazardous Air Pollutants

NYSDEC = New York State Department of Environmental Conservation

NA = Not Applicable

OU = Operable Unit

REF = Radiation Effects Facility

RTF = Radiation Therapy Facility

RHIC = Relativistic Heavy Ion Collider

SDWA = Safe Drinking Water Act

STP = Sewage Treatment Plant

WMF = Waste Management Facility

pollution. Both conventional and hazardous air pollutants are regulated under the CAA.

3.5.1 Conventional Air Pollutants

BNL has a variety of conventional, nonradioactive air emission sources that are subject to federal or state regulations. The following subsections describe the more significant sources and the methods used by BNL to comply with the applicable regulatory requirements.

3.5.1.1 Boiler Emissions

BNL has four boilers (Nos. 1A, 5, 6, and 7) at the Central Steam Facility that are subject to NYSDEC Reasonably Available Control Technology (RACT) requirements. Three of the boilers can burn either residual fuel oil or natural gas; Boiler 1A burns fuel oil only. In 2004, low nitrogen residual oil (below 0.3 percent) was the predominant fuel burned in all four boilers.

For boilers with maximum operating heat inputs greater than or equal to 50 MMBtu/hr (14.6 MW), RACT requirements establish emissions standards for oxides of nitrogen (NO_x). Boilers with a maximum operating heat input between 50 and 250 MMBtu/hr (14.6 and 73.2 MW) can demonstrate compliance using periodic emission tests or by using continuous emission monitoring equipment. Emission tests conducted in 1995 confirmed that BNL Boilers 1A and 5, both in this size category, met the NO_x emission standards when burning residual fuel oil with low nitrogen content. To ensure continued compliance, each year an outside contract laboratory analyzes composite samples (collected quarterly) of fuel deliveries. The analyses conducted in 2004 confirmed that the fuel-bound nitrogen content met these requirements. Compliance with the 0.30 lbs/MMBtu NO_x emission standards for Boilers 6 and 7 was demonstrated by continuous emission monitoring of the flue gas. In 2004, NO_x emissions from Boilers 6 and 7 averaged 0.256 lbs/MMBtu and 0.210 lbs/MMBtu, respectively, and there were no known exceedances of the NO_x emission standard for either boiler.

3.5.1.2 Ozone-Depleting Substances

Refrigerants. BNL's preventative maintenance program requires regular inspection and maintenance of refrigeration and air conditioning equipment that contains ozone-depleting substances (ODS) such as R-11, R-12, and R-22. All refrigerant recovery and recycling equipment used by trained technicians is certified to meet refrigerant evacuation levels specified by 40 CFR 82.158. As a matter of standard practice at BNL, if a refrigerant leak is found, technicians will either immediately repair the leak or isolate it and prepare a work order for the needed repairs. This practice exceeds the leak repair provisions of 40 CFR 82.156. In 2004, approximately 450 pounds of R-11, 4 pounds of R-12, and 185 pounds of R-22 were recovered and recycled from refrigeration equipment that was serviced.

Halon. Halon 1211 and 1301 are extremely efficient fire suppressants but are being phased out, due to their effect on the Earth's ozone

layer. In 1998, BNL purchased equipment to comply with the halon recovery and recycling requirements of the CAA, 40 CFR 82 Subpart H. When portable fire extinguishers or fixed systems are removed from service and when halon cylinders are periodically tested, BNL workers use halon recovery and recycling devices, to comply with the CAA provisions.

In July 2004, BNL successfully negotiated the transfer of excess Halon 1301 and Halon 1011 to the Department of Energy Savannah River Site ODS Repository. In total, 5,284 pounds of excess Halon 1301 and approximately 175 pounds of excess Halon 1011 were transferred. The fire suppressants sent to the ODS Repository had accumulated over several years as fixed fire suppression systems in buildings were dismantled because they were no longer needed, or as the result of ODS systems being replaced with systems that use alternative agents.

3.5.2 Hazardous Air Pollutants

In 1970, the CAA established standards to protect the general public from hazardous air pollutants that may lead to death or an increase in irreversible or incapacitating illnesses. The NESHAPs were updated significantly in 1990. EPA developed a program to limit the emission of 189 toxic air pollutants. This program included a list of regulated contaminants, a schedule for implementing control requirements, aggressive technology-based emission standards, industry-specific requirements, special permitting provisions, and a program to address accidental releases. The following subsections describe BNL's compliance with NESHAPs regulations.

3.5.2.1 Maximum Available Control Technology

During preparation of the Title V Phase II application, BNL reviewed existing state and federal regulations administered under the CAA to determine applicability to BNL activities and operations. Based on this review, it was concluded that no proposed or promulgated Maximum Available Control Technology (MACT) standards apply to BNL operations. Additional evaluation conducted in 2004 determined that no MACT standards apply to the anticipated emissions from proposed activities or operations.

3.5.2.2 Asbestos

As required, BNL provided notice to the EPA Region II office regarding the removal of materials that contained asbestos. During 2004, 1,116 linear ft of asbestos-containing pipe insulation, 7,495 ft² of asbestos-containing surface material (siding, roofing, and vinyl asbestos floor tile removed during demolition or renovation activities), and 400 yd³ of bulk asbestos waste (generated during demolition of facilities) were removed and disposed of in accordance with EPA requirements.

3.5.2.3 Radioactive Airborne Emissions

Emissions of radiological contaminants are evaluated and, if necessary, monitored to ensure that they do not impact the environment or people residing near BNL. A full description of this monitoring in 2004 is provided in Chapter 4. BNL transmitted all data pertaining to radioactive air emissions and dose calculations to EPA on schedule, in fulfillment of the June 30 annual reporting requirement. In 2004, the maximum off-site dose due to airborne radioactive emissions from BNL continued to be far below the 10 mrem (100 μ Sv) annual dose limit specified in 40 CFR 61 Subpart H. See Chapters 4 and 8 for more information on the estimated air dose. The dose to the hypothetical maximally exposed individual (MEI) resulting from airborne emissions, calculated using EPA's modeling software, was 0.043 mrem (0.43 μ Sv).

3.6 CLEAN WATER ACT

The disposal of wastewater generated by BNL operations is regulated under the Clean Water Act (CWA), as implemented by NYSDEC and under DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. The goals of the CWA are to achieve a level of water quality that promotes the propagation of fish, shellfish, and wildlife; to provide waters suitable for recreational purposes; and to eliminate the discharge of pollutants into surface waters. New York State was delegated CWA authority in 1975. NYSDEC has issued a SPDES permit to regulate wastewater effluents at BNL. This permit establishes release concentration limits and specifies monitoring requirements.

The BNL SPDES permit was modified in February 2004. This permit provides monitoring requirements and specifies effluent limits for nine of 13 outfalls, as described below. See Figure 5-6 in Chapter 5 for the locations of BNL outfalls.

- Outfall 001 is used for the discharge of the treated effluent from the STP to the Peconic River.
- Outfalls 002, 002B, 003, 005, 006A, 006B, 008, 010, 011, and 012 are recharge basins used to discharge cooling tower blowdown, once-through cooling water, and/or stormwater. NYSDEC does not require BNL to monitor Outfalls 003, 011, and 012.
- Outfall 007 receives backwash water from the potable Water Treatment Plant filter building.
- Outfall 009 consists of numerous subsurface and surface wastewater disposal systems that receive predominantly sanitary waste, and steam- and air-compressor condensate discharges. NYSDEC does not require monitoring of this outfall.

Each month, BNL prepares Discharge Monitoring Reports that detail monitoring data, evaluate compliance with permit limitations, and identify corrective measures taken to address permit excursions. Reports are submitted directly to the NYSDEC central and regional offices and the Suffolk County Department of Health Services (SCDHS). Details of the monitoring program conducted for the groundwater treatment and SPDES Equivalency performance are provided in Volume II of the SER, *Groundwater Status Report*.

3.6.1 Sewage Treatment Plant

Sanitary and process wastewater generated by BNL operations is conveyed to the STP for processing before discharge to the Peconic River. The STP provides tertiary treatment of this wastewater (settlement/sedimentation, biological reduction of organic matter, and reduction of nitrogen). Chapter 5 provides a detailed description of the treatment process.

A summary of the SPDES monitoring results for the STP discharge at Outfall 001 is provided in Table 3-3. The relevant SPDES permit limits

Table 3-3. Analytical Results for Wastewater Discharges to Sewage Treatment Plant Outfall 001.

Analyte	Lowest Reported	Highest Reported	Min. Monitoring Frequency	SPDES Limit	No. of Exceedances	% Compliance*
Max. temperature (°F)	48	84	Daily	90	0	100
pH (SU)	5.9	7.7	Continuous Recorder	Min. 5.8	0	100
Avg. 5-day BOD (mg/L)	< 2	< 2	Twice Monthly	10	0	100
Max. 5-day BOD (mg/L)	< 2	< 2	Twice Monthly	20	0	100
% BOD removal	> 94	> 99	Monthly	85	0	100
Avg. TSS (mg/L)	< 1.0	14 (a,c)	Monthly	10	1	92
Max. TSS (mg/L)	< 1.0	18	Twice Monthly	20	0	100
% TSS removal	> 82 (a,c)	> 99	Monthly	85	1	92
Settleable solids (ml/L)	0.0	0.0	Daily	0.1	0	100
Ammonia nitrogen (mg/L)	< 0.10	0.6	Twice Monthly	2	0	100
Total nitrogen (mg/L)	3.3	9.9	Twice Monthly	10	0	100
Total phosphorus (mg/L)	0.37	2.3	Twice Monthly	NA	0	100
Cyanide (µg/L)	< 5.0	18.7	Twice Monthly	100	0	100
Copper (mg/L)	0.035	0.057	Twice Monthly	0.15	0	100
Iron (mg/L)	0.10	0.87(b,c)	Twice Monthly	0.37	2	92
Lead (mg/L)	< 0.0030	0.0074	Twice Monthly	0.019	0	100
Nickel (mg/L)	0.0034	0.024	Twice Monthly	0.11	0	100
Silver (mg/L)	0.0016	0.0054	Twice Monthly	0.015	0	100
Zinc (mg/L)	0.03	0.1	Twice Monthly	0.1	0	100
Mercury (mg/L)	< 0.0002	0.0002	Twice Monthly	0.0008	0	100
Toluene (µg/L)	< 1.0	< 5.0	Twice Monthly	5	0	100
Methylene chloride (µg/L)	< 1.0	11.0 (d)	Twice Monthly	5	2	92
1,1,1-trichloroethane (µg/L)	< 1.0	< 5.0	Twice Monthly	5	0	100
2-butanone (µg/L)	< 2.0	9.8	Twice Monthly	50	0	100
PCBs (µg/L)	< 0.065	< 0.65	Quarterly	NA	0	100
Max. flow (MGD)	0.31	0.67	Continuous Recorder	2.3	0	100
Avg. flow (MGD)	0.25	0.49	Continuous Recorder	NA	0	100
Avg. fecal coliform (MPN/100 mL)	< 2	2	Twice Monthly	200	0	100
Max. fecal coliform (MPN/100 mL)	< 2	2	Twice Monthly	400	0	100

Notes:

See Chapter 5, Figure 5-6 for location of Outfall 001.

*% Compliance = [(total no. samples – total no. exceedances) / total no. of samples] x 100

BOD = Biological Oxygen Demand

MGD = Million Gallons per Day

MPN = Most Probable Number

NA = Not Applicable

SU = Standard Unit

TSS = Total Suspended Solids

- (a) Two composite samples collected on June 4 and June 7, 2004, exhibited total suspended solids concentrations of 18 and 10 mg/L respectively. Due to the elevated concentrations, the average TSS concentration and the calculated percent removal exceeded the permit limits.
- (b) Two permit exceedances of the total iron concentration occurred on June 4 and June 7, 2004.
- (c) An investigation into the exceedances found that the sample collection probe was lying on the bottom of the flow channel and was likely collecting sediment.
- (d) Grab samples collected on April 2, 2004 and May 3, 2004 exceeded the permit limits. An investigation found that the analytical laboratory performing these analyses had a solvent contamination problem, and therefore the exceedances are not real.

are also shown. BNL monitors the STP discharge for more than 100 parameters monthly and more than 200 parameters quarterly. BNL's compliance with effluent limits was greater than 99 percent overall. There were six excursions of

the SPDES permit limits for this outfall in 2004: two for methylene chloride, two for iron, and one each for suspended solids, and suspended solids removal. Each of these excursions was investigated, as follows.

In April and May, methylene chloride was detected in the discharge at 7 and 11 µg/L, respectively. Because methylene chloride is a common laboratory contaminant, cross contamination at the analytical lab was suspected. To check this, BNL sent blank samples (containing no contamination) for analysis. All the blank samples were reported to contain methylene chloride. A subsequent evaluation by the contract laboratory showed cross contamination occurring at their facility. A copy of their assessment was provided to NYSDEC. In June, two samples showed high levels of iron and suspended solids. Examination of the sampling equipment showed that when the sample collection tubing was replaced, the end probe was put on the bottom of the channel, where it collected settled particulates. Repositioning the probe midstream showed the levels of iron and suspended solids to be lower and well within permit limits. Because the concentration of suspended solids was high in the original effluent sample, removal of 85 percent of the incoming solids could not be demonstrated. Figures 3-1 through 3-7 plot 5-year trends for the maximum monthly concentrations of copper, iron, lead, mercury, nickel, silver, and zinc in the STP discharge.

3.6.1.1 Chronic Toxicity Testing

BNL's SPDES permit requires that "whole effluent toxicity" (WET) tests be conducted to ensure that chemicals present in the STP efflu-

ent are not toxic to aquatic organisms. BNL's chronic toxicity testing program began in 1993 and continued through 2003. In 2004, toxicity testing was postponed and will be restarted in March 2005 as stipulated in the February 2004 SPDES permit modification. Under the WET testing provisions, samples are collected and tested quarterly. The program consists of 7-day chronic toxicity testing on two freshwater organisms, water fleas and fathead minnows. Sets of 10 of these organisms are exposed to varying concentrations of the STP effluent (100, 50, 25, 12.5, and 6.25 percent) for 7 days in each test. During testing, the growth rate of the fish and rate of reproduction for the water flea are measured and compared to untreated organisms (i.e., controls). The test results are submitted to NYSDEC for review.

3.6.2 Recharge Basins and Stormwater

Outfalls 002 through 008 and Outfalls 010 through 012 discharge to groundwater, replenishing the underlying aquifer. Monitoring requirements for each of these discharges vary, depending on the type of wastewater received and the type of cooling water treatment reagents used. Table 3-4 summarizes the monitoring requirements and performance results for 2004. Review of the data shows that all discharges were in full compliance with SPDES requirements. No permit excursions were recorded at any of these outfalls in 2004.

Figure 3-1. Maximum Concentrations of Copper Discharged from the BNL Sewage Treatment Plant, 2000–2004.

Figure 3-2. Maximum Concentrations of Iron Discharged from the BNL Sewage Treatment Plant, 2000–2004.

Figure 3-3. Maximum Concentrations of Lead Discharged from the BNL Sewage Treatment Plant, 2000–2004.

Figure 3-4. Maximum Concentration of Mercury Discharged from the BNL Sewage Treatment Plant, 2000–2004.

Figure 3-5. Maximum Concentration of Nickel Discharged from the BNL Sewage Treatment Plant, 2000–2004.

Figure 3-6. Maximum Concentration of Silver Discharged from the BNL Sewage Treatment Plant, 2000–2004.

Figure 3-7. Maximum Concentration of Zinc Discharged from the BNL Sewage Treatment Plant, 2000–2004.

Table 3-4. Analytical Results for Wastewater Discharges to Outfalls 002–008 and 010.

Analyte	Outfall 002	Outfall 002B	Outfall 005	Outfall 006A	Outfall 006B	Outfall 007	Outfall 008	Outfall 010	SPDES Limit	No. of Exceedances	% Compliance*
Flow (MGD)	N	CR	CR	CR	CR	CR	11	10			
	Min.	0.02	0.0002	0.24	0.03	0.16	0.002	0.001	NPL		
	Max.	0.26	0.054	0.77	0.16	0.40	0.38	0.23	NPL	NA	NA
pH (SU)											
	Min.	6.5	7.1	6.7	6.2	6.2	6.1	6.6	NA		
	Max.	8.4	8.6	8.5	8.5	8.4	8.1	7.7	8.5, 9.0 (a)	0	100
Oil and grease (mg/L)											
	N	12	11	12	10	NR	10	10			
	Min.	< 5.0	< 5.0	< 5.0	< 5.0	NR	< 5.0	< 5.0	NA		
	Max.	< 5.0	4.1	< 5.0	< 5.0	NR	6.1	3.3	15	0	100
Copper (mg/L)											
	N	NR	NR	4	NR	NR	NR	4			
	Min.	NR	NR	< 0.01	NR	NR	NR	< 0.01	NA		
	Max.	NR	NR	0.006	NR	NR	NR	0.005	1.0	0	100
Aluminum (mg/L)											
	N	4	NR	NR	NR	NR	4	4			
	Min.	< 0.05	NR	NR	NR	NR	< 0.05	< 0.05	NA		
	Max.	0.67	NR	NR	NR	NR	0.03	0.15	2.0	0	100
Lead (mg/L)											
	N	NR	NR	NR	NR	NR	NR	4			
	Min.	NR	NR	NR	NR	NR	NR	< 0.003	NA		
	Max.	NR	NR	NR	NR	NR	NR	0.002	0.05	0	100
Vanadium (mg/L)											
	N	NR	NR	NR	NR	NR	NR	4			
	Min.	NR	NR	NR	NR	NR	NR	0.003	NA		
	Max.	NR	NR	NR	NR	NR	NR	0.013	NPL	NA	NA
Chloroform (µg/L)											
	N	4	NR	NR	NR	NR	NR	NR			
	Min.	< 1.0	NR	NR	NR	NR	NR	NR	NA		
	Max.	0.51	NR	NR	NR	NR	NR	NR	7	0	100
Bromo-dichloromethane (µg/L)											
	N	4	NR	NR	NR	NR	NR	NR			
	Min.	< 1.0	NR	NR	NR	NR	NR	NR	NA	NA	
	Max.	< 1.0	NR	NR	NR	NR	NR	NR	5	0	100

(continued on next page)

Table 3-4. Analytical Results for Wastewater Discharges to Outfalls 002–008 and 010 (concluded).

Analyte	Outfall 002	Outfall 002B	Outfall 005	Outfall 006A	Outfall 006B	Outfall 007	Outfall 008	Outfall 010	SPDES Limit	No. of Exceedances	% Compliance*
1,1,1-trichloroethane (µg/L)	N	4	NR	NR	NR	NR	4	NR			
	Min.	< 1.0	NR	NR	NR	NR	< 1.0	NR	NA	NA	
	Max.	< 1.0	NR	NR	NR	NR	< 5.0	NR	5	0	100
1,1-dichloroethylene (µg/L)	N	NR	NR	NR	NR	NR	4	NR			
	Min.	NR	NR	NR	NR	NR	< 1.0	NR	NA	NA	
	Max.	NR	NR	NR	NR	NR	< 5.0	NR	5	0	100
Hydroxyethylidene-diphosphonic acid (mg/L)	N	4	4	4	4	NR	NR	NR			
	Min.	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	NR	NA	NA	
	Max.	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	NR	0.5	0	100
Tolyltriazole (mg/L)	N	4	4	4	4	NR	NR	NR			
	Min.	< 0.005	< 0.005	< 0.005	< 0.005	NR	NR	NR	NA	NA	
	Max.	< 0.005	< 0.005	< 0.005	< 0.005	NR	NR	NR	0.2	0	100

Notes:

See Chapter 5, Figure 5-6 for locations of outfalls.

There are no monitoring requirements for Outfalls 009, 011, and 012.

*% Compliance = [(total no. samples – total no. exceedances)/total no. of samples] x 100

CR = Continuous Recorder

MGD = Million Gallons per Day

Max. = Maximum value

Min. = Minimum value

N = Number of samples

NA = Not Applicable

NPL = No permit limit, monitoring only

NR = Analysis Not Required

SU = Standard Unit

(a) pH limit is 8.5 for Outfalls 005, 008, and 010. pH limit is 9.0 for Outfalls 002, 002B, 003, 006A, 006B, and 007.

3.7 SAFE DRINKING WATER ACT

The distribution and supply of drinking water is regulated under the federal SDWA. In New York State, implementation of the SDWA is delegated to the New York State Department of Health (NYSDOH) and administered by SCDHS. Because BNL provides potable water to “more than 25 full-time residents,” it is subject to the same requirements as a public water supplier. Monitoring requirements are prescribed annually by SCDHS, and a *Potable Water Sampling and Analysis Plan* (Chaloupka 2004) is prepared to comply with these requirements.

3.7.1 Potable Water

BNL maintains six ground-water wells for on-site distribution of potable water. To meet New York State Drinking Water Standards (DWS), groundwater is treated with activated carbon or air stripping to remove volatile organic compounds (VOCs). Groundwater from three of the six wells is also treated to reduce naturally occurring iron. As required by NYSDOH regulations, BNL monitors the potable wells regularly for bacteria, inorganics, organics, and pesticides. BNL also voluntarily monitors drinking water supplies for radiological contaminants. Tables 3-5 and 3-6 provide the potable water supply monitoring data for 2004. Color and iron exceeded DWS in samples collected from three of the wells (wells 4, 6, and 7), before distribution. Treatment at the Water Treatment Plant effectively re-

duced these levels to below DWS. At the point of consumption, drinking water complied with all DWS during 2004. Chapter 7 provides additional data on environmental surveillance tests performed on potable wells. This additional testing goes beyond the minimum SDWA testing requirements.

3.7.2 Cross-Connection Control

The SDWA requires that public water suppliers implement practices to protect the water supply from sanitary hazards. One of the safety requirements is to rigorously prevent connections between the potable water supply and connections to systems containing hazardous substances ("cross connections"). Cross-connection control is the installation of control devices (e.g., double check valves, reduced pressure zone valves, etc.) at the interface between a facility and the domestic water main. Cross-connection control devices are required at all facilities where hazardous materials are used in a manner that could result in their introduction

into the domestic water system, especially under low-pressure conditions. In addition, secondary cross-connection controls at the point of use are recommended, to protect users within a specific facility from hazards that might be posed by intra-facility operations.

BNL has installed and maintains approximately 200 cross-connection control devices at interfaces to the potable water main, and secondary control devices at the point of use. Approximately 175 cross-connection control units were tested in 2004, including primary and secondary devices. If a problem is encountered during testing, the device is repaired and retested to ensure proper function. In 2004, no cross-contamination problems were reported.

3.7.3 Underground Injection Control

UIC wells are regulated under the SDWA. At BNL, UICs include drywells, cesspools, septic tanks, and leaching pools, all of which are classified by EPA as Class V injection wells. Proper management of UIC devices is vital for protect-

Table 3-5. Potable Water Wells and Potable Distribution System: Analytical Results (Maximum Concentration, Minimum pH Value).

Compound	Well No. 4	Well No. 6	Well No. 7	Well No. 10	Well No. 11	Well No. 12	Potable Distribution Sample	NYS DWS
Water Quality Indicators								
Total coliform	ND	ND	ND	ND	ND	ND	ND	Negative
Color (units)	50*	< 5	< 5	< 5	< 5	< 5	< 5	15
Odor (units)	0	0	0	0	0	0	0	3
Cyanide (µg/L)	NA	< 10	< 10	< 10	< 10	< 10	< 10	SNS
Conductivity (µmhos/cm)	146	129	148	102	272	256	251	SNS
Chlorides (mg/L)	NA	22.5	21.9	10.8	17.8	18.3	25.7	250
Sulfates (mg/L)	NA	9.9	9.8	8.4	12.7	11.5	10.1	250
Nitrates (mg/L)	NA	0.15	0.15	< 0.10	0.46	0.49	0.26	10
Nitrites (mg/L)	NA	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.10	1.0
Ammonia (mg/L)	NA	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	SNS
pH (Standard Units)	5.9	6.0	5.9	6.1	6.0	6.1	6.5	SNS
MBAS (mg/L)	NA	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	SNS
Metals								
Antimony (µg/L)	NA	< 5.90	< 5.90	< 5.90	< 5.90	< 5.90	< 5.90	6.0
Arsenic (µg/L)	NA	< 3.00	< 3.00	< 3.00	< 3.00	< 3.00	< 3.00	50

(continued on next page)

Table 3-5. Potable Water Wells and Potable Distribution System: Analytical Results (Maximum Concentration, Minimum pH Value).

Compound	Well No. 4	Well No. 6	Well No. 7	Well No. 10	Well No. 11	Well No. 12	Potable Distribution Sample	NYS DWS
Barium (mg/L)	NA	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	2.0
Beryllium (µg/L)	NA	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	4.0
Cadmium (µg/L)	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5.0
Chromium (mg/L)	NA	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.1
Fluoride (mg/L)	NA	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	2.2
Iron (mg/L)	NA	4.33*	1.82*	0.044	< 0.02	0.025	0.150	0.3
Lead (µg/L)	NA	< 1.0	< 1.0	< 1.0	< 1.0	2.54	1.60	15
Manganese (mg/L)	NA	0.094	0.063	< 0.010	< 0.010	< 0.010	0.21	0.3
Mercury (µg/L)	NA	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.30	2.0
Nickel (mg/L)	NA	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	SNS
Selenium (µg/L)	NA	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	50.0
Sodium (mg/L)	NA	12.8	14.1	11.1	14.0	13.7	17.6	SNS
Silver (µg/L)	NA	< 10	< 10	< 10	< 10	< 10	< 10	100
Thallium (µg/L)	NA	< 1.90	< 1.90	< 1.90	< 1.90	< 1.90	< 1.90	2.0
Zinc (mg/L)	NA	< 0.020	< 0.020	< 0.020	< 0.020	0.034	< 0.020	5.0
Radioactivity								
Gross alpha activity (pCi/L)	NA	< 1.7	< 1.5	NA	< 1.4	< 1.6	NR	15.0
Gross beta activity (pCi/L)	NA	2.2 ± 1.2	< 1.8	NA	< 1.9	2.4 ± 1.3	NR	(a)
Tritium (pCi/L)	NA	< 310	< 310	NA	< 310	340	NR	20,000
Strontium-90 (pCi/L)	NA	< 0.89	< 0.74	NA	< 0.80	< 0.78	NR	8.0
Other								
Asbestos (Million fibers/L)	NR	NR	NR	NR	NR	NR	< 0.17	7
Calcium (mg/L)	5.48	4.77	5.47	5.09	6.30	7.10	10.2	SNS
Alkalinity (mg/L)	11.6	8.4	12.2	20.3	17.3	21.4	48.2	SNS
Residual chlorine - MRDL (mg/L)	NR	NR	NR	NR	NR	NR	0.8	4.0
TTHM (mg/L)	NR	NR	NR	NR	NR	NR	0.01	0.08**
HAA5 (mg/L)	NR	NR	NR	NR	NR	NR	0.01	0.06**

Notes:

See Figure 7-3 for well locations.

HAA5 = Five Haloacetic Acids

MBAS = Methylene Blue Active Substances

MRDL = Maximum Residual Disinfectant Level

NA = Not Analyzed due to well shutdown in April 2004

ND = Not Detected

NR = Analysis Not Required

NYS DWS = New York State Drinking Water Standard

SNS = Drinking Water Standard Not Specified

TTHM = Total Trihalomethanes

* Water from these wells is treated at the Water Treatment Plant for color and iron reduction prior to site distribution.

** Limit imposed on distribution samples only.

(a) The drinking water standard was changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in late 2003. Since gross beta activity does not identify specific radionuclides, a dose equivalent can not be calculated for the values in the table.

Table 3-6. Potable Water Wells: Analytical Results for Principal Organic Compounds, Synthetic Organic Chemicals, Pesticides, and Micro-Extractables (Maximum Concentration).

Compound	WTP Effluent	Well No. 4	Well No. 6	Well No. 7	Well No. 10	Well No. 11	Well No. 12	NYS DWS
	µg/L							
Dichlorodifluoromethane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Chloromethane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Vinyl Chloride	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	2
Bromomethane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Chloroethane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Trichlorofluoromethane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,1-dichloroethene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Methylene Chloride	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
trans-1,2-dichloroethene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,1-dichloroethane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
cis-1,2-dichloroethene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
2,2-dichloropropane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Bromochloromethane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,1,1-trichloroethane	0.6	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Carbon Tetrachloride	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,1-dichloropropene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,2-dichloroethane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Trichloroethene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,2-dichloropropane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Dibromomethane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
trans-1,3-dichloropropene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
cis-1,3-dichloropropene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,1,2-trichloroethane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,3-dichloropropane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Chlorobenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,1,1,2-tetrachloroethane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Bromobenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,2,3-trichloropropane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
2-chlorotoluene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
4-chlorotoluene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,3-dichlorobenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,4-dichlorobenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,2-dichlorobenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,2,4-trichlorobenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Hexachlorobutadiene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5

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CHAPTER 3: COMPLIANCE STATUS

Table 3-6. Potable Water Wells: Analytical Results for Principal Organic Compounds, Synthetic Organic Chemicals, Pesticides, and Micro-Extractables (Maximum Concentration) (continued).

Compound	WTP Effluent	Well No. 4	Well No. 6	Well No. 7	Well No. 10	Well No. 11	Well No. 12	NYS DWS
Tetrachloroethene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,1,2,2-Tetrachloroethane	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,2,3-trichlorobenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Benzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Toluene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Ethylbenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
m,p-xylene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
o-xylene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Styrene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Isopropylbenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
n-propylbenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,3,5-trimethylbenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
tert-butylbenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
1,2,4-trimethylbenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
sec-butylbenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
4-Isopropyltoluene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
n-butylbenzene	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Methyl tert-butyl ether	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Lindane	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	0.2
Heptachlor	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	0.4
Aldrin	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Heptachlor Epoxide	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	0.2
Dieldrin	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Endrin	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	0.2
Methoxychlor	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	40
Toxaphene	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	3
Chlordane	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	2
Total PCBs	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	0.5
2,4,5,-TP (Silvex)	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	10
Dinoseb	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Dalapon	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Picloram	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Dicamba	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Pentachlorophenol	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	1
Hexachlorocyclopentadiene	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5

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Table 3-6. Potable Water Wells: Analytical Results for Principal Organic Compounds, Synthetic Organic Chemicals, Pesticides, and Micro-Extractables (Maximum Concentration) *(continued)*.

Compound	WTP Effluent	Well No. 4	Well No. 6	Well No. 7	Well No. 10	Well No. 11	Well No. 12	NYS DWS
				µg/L				
Bis(2-ethylhexyl)Phthalate	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Bis(2-ethylhexyl)Adipate	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Hexachlorobenzene	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	5
Benzo(A)Pyrene	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Aldicarb Sulfone	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	SNS
Aldicarb Sulfoxide	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	SNS
Aldicarb	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	SNS
Oxamyl	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
3-Hydroxycarbofuran	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Carbofuran	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	40
Carbaryl	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Methomyl	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Glyphosate	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Diquat	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
1,2-dibromomethane (EDB)	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	0.05
1,2-dibromoethane	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	0.05
1,2-dibromo-3-chloropropane	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	0.2
2,4,-D	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Alachlor	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	2
Simazine	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Atrazine	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	3
Metolachlor	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Metribuzin	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Butachlor	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Endothall	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	100
Propachlor	NR	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	50
Chloroform	NR	40	1.0	1.2	1.6	<MDL	<MDL	50
Bromodichloromethane	<MDL	2.8	<MDL	<MDL	1.0	<MDL	<MDL	50
Dibromochloromethane	< MDL	0.5	<MDL	< MDL	0.6	< MDL	< MDL	50
Bromoform	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	50

Notes:

See Chapter 7, Figure 7-3 for well locations.

For compliance determination with New York State Department of Health standards, potable water samples were analyzed quarterly or annually depending on the analyte by H2M Labs Inc., a New York State-certified contractor laboratory.

The minimum detection limits for principal organic compound analytes are 0.5 µg/L. Minimum detection limits for synthetic organic chemicals and micro-extractables are compound-specific, and in all cases are less than the New York State Department of Health drinking water standard.

< MDL = Less than the Minimum Detection Limit for the analyte in question

NR = Analysis Not Required

SNS = Drinking Water Standard Not Specified

NYS DWS = New York State Drinking Water Standard

WTP = Water Treatment Plant

ing underground sources of drinking water. In New York State, the UIC program is implemented through EPA, since NYSDEC did not adopt UIC regulatory requirements. (New York State regulates discharges of pollutants to cesspools under the SPDES program.) Under EPA's UIC program, all Class V injection wells must be included in an inventory maintained with the agency. There were no changes to the BNL UIC inventory in 2004.

In addition to the UICs maintained for routine Laboratory discharges of sanitary waste and stormwater, UICs also are maintained at several on- and off-site treatment facilities used for groundwater remediation. Contaminated groundwater is treated and then returned to the aquifer via drywells, injection wells, or recharge basins. Discharges to UICs are regulated by EPA, and a separate inventory is maintained for these treatment facilities.

3.8 SPILL PREVENTION, EMERGENCY PLANNING, AND REPORTING

Several federal, state, and local regulations address the management of storage facilities containing chemicals, petroleum, and other hazardous materials. These regulations include specifications for storage facilities, requirements for release planning documentation, and release reporting. The following subsections describe BNL's compliance with these regulations.

3.8.1 Preventing Oil Pollution and Spills

BNL must maintain a *Spill Prevention Control and Countermeasures Plan* (Chaloupka 2000) (SPCC Plan) as a condition of its Major Petroleum Facility License and as required by the Oil Pollution Act. This plan is part of BNL's emergency preparedness program and outlines mitigating and remedial actions that would be taken in the event of a major petroleum release. The plan also provides information regarding

release prevention measures, the design of storage facilities, and maps detailing their locations. The SPCC Plan is filed with NYSDEC, EPA, and DOE, and was last updated in December 2000. In July 2002, EPA adopted significant changes to the SPCC regulations, which extended the requirements to previously unregulated facilities and provided some relief to existing covered facilities. These changes, among others, included extending the plan update deadline from 3 to 5 years, and specifying that containers less than 55 gallons need not be counted toward reaching SPCC applicability. The timeline for updating BNL's SPCC Plan to incorporate these changes has therefore been extended until February 2006, and BNL is proceeding with changes to the plan. The revised plan must be implemented by August 2006. BNL remained in full compliance with the SPCC requirements in 2004.

BNL also maintains a *Facility Response Plan* (Lee 2002). The Facility Response Plan (FRP) outlines emergency response procedures to be implemented in the event of a worst-case discharge of oil. There were no comments from EPA regarding revisions to the FRP submitted in September 2002; consequently there were no actions on the FRP in 2004.

3.8.2 Local and State Emergency Reporting Requirements

The Emergency Planning and Community Right-to-Know Act (EPCRA) and Title III of the Superfund Amendments and Reauthorization Act (SARA) require that facilities report inventories and releases of certain chemicals that exceed specific thresholds to the local emergency planning committee and the state emergency response commission. Community Right-to-Know requirements are codified under 40 CFR Parts 355, 370, and 372. The table below summarizes the applicability of the regulations to BNL.

Applicability of EPCRA to BNL				
EPCRA 302–303	Planning Notification	YES [X]	NO []	NOT REQUIRED []
EPCRA 304	EHS Release Notification	YES []	NO []	NOT REQUIRED [X]
EPCRA 311–312	MSDS/Chemical Inventory	YES [X]	NO []	NOT REQUIRED []
EPCRA 313	TRI Reporting	YES [X]	NO []	NOT REQUIRED []

BNL complied with these requirements in 2004 through the submittal of reports under EPCRA Sections 302, 303, 311, and 312. During 2000 and 2001, the Part 313 Toxic Release Inventory (TRI) thresholds were significantly lowered for mercury, PCBs, and lead. Mercury and PCB thresholds were lowered from 10,000 pounds to 10 pounds, and lead from 10,000 to 100 pounds. In addition to these three classes of contaminants, review of EPA guidance regarding the reporting requirements for other “persistent, bioaccumulative, and toxic” chemicals (PBTs) was reviewed and two additional classes of chemicals were identified for reporting in 2004: benzo(g,h,i)perylene, and polycyclic aromatic compounds. These two classes of compounds are associated with the combustion of fuel oil and the paving of roads. Emissions estimates for these classes were based on EPA-published emission factors. In 2004, BNL submitted Tier III reports for lead (~ 165,000 pounds), mercury (~ 600 pounds), PCBs (~ 57 pounds), benzo(g,h,i)perylene (< 1 pound), and polycyclic aromatic compounds (< 1 pound). In 2004, there were no releases of “extremely hazardous substances” that are reported under Part 304.

3.8.3 Spills and Releases

When a spill of hazardous material occurs, BNL personnel are required to immediately notify the on-site Fire Rescue Group, whose members are trained to respond to such releases. The initial step in spill response is to contain and control any release and to notify additional response personnel (i.e., BNL environmental professionals, industrial hygienists, etc.). Environmental professionals reporting to the scene assess the spill for environmental impact and determine if it is reportable to regulatory agencies. Any release of petroleum products to soil is reportable to both NYSDEC and SCDHS, and any release impacting a surface water is also reportable to the EPA National Response Center. In addition, releases of petroleum products in volumes greater than 5 gallons to impermeable surfaces or containment areas are also reported to NYSDEC and SCDHS. Spills of chemicals in quantities greater than CERCLA-reportable quantities are reportable to the

EPA National Response Center, NYSDEC, and SCDHS. Remediation of the spill is conducted, as necessary, to restore the site.

During 2004, there were 76 spills, of which 30 met external agency reporting criteria. The 30 reports are summarized in Table 3-7. The remaining 46 releases were small-volume releases either to containment areas or to other impermeable surfaces that did not exceed a reportable quantity. Nineteen of the 30 reported releases involved very small volumes (< 5 gallons) of petroleum products that reached soil. New York State has a “zero tolerance” level for releases of petroleum products to soil or water; consequently, spills of any amount to soil are reportable. Four of the 30 were small-volume releases of ethylene glycol from engine coolant leaks. There were seven large-volume (i.e., > 10 gallons) releases recorded in 2004. Two of the seven were petroleum releases discovered during tank removal projects, two were associated with failed equipment at the Brookhaven Linear Isotope Producer that released water containing low-levels of radioactivity into secondary containment, two were releases of oils associated with failed equipment, and one was the release of PCB-contaminated oil from two transformers that were knocked over in a storage yard by an unknown cause. Table 3-7 contains a summary of each of these incidents, including a description of the cause, corrective actions taken, and whether the spill was reportable to DOE through the Occurrence Reporting and Processing System (ORPS).

In 2004, there were 13 incidents reported through ORPS that were environmental in nature. Six of these reports were spill-related and have been summarized in Table 3-7; the remaining seven are summarized in Table 3-8. All incidents were addressed through the identification and implementation of corrective actions geared toward the root cause. No off-site or on-site permanent environmental impacts arose from the ORPS-reported incidents.

3.8.4 Major Petroleum Facility License

The storage of 2.3 million gallons of petroleum products (principally No. 6 fuel oil) subjects BNL to Major Petroleum Facility licensing by NYSDEC. BNL maintains an MPF license for

storing and transferring oil at the Central Steam Facility. During 2004, BNL remained in full compliance with license requirements. The license requires BNL to monitor groundwater in the vicinity of the six active, aboveground storage tanks that range in size from 300,000 to 600,000 gallons. The license also requires that BNL inspect storage facilities monthly and test the systems for leak detection, high-level monitoring, and secondary containment. Tank integrity is also checked periodically. Groundwater monitoring consists of monthly checks for floating products and twice-yearly analyses for volatile and semivolatile organic compounds. In 2004, no contaminants or floating products

attributable to MPF activities were found in the downgradient groundwater wells. See Volume II of the SER, *Groundwater Status Report*, for additional information on groundwater monitoring results.

The following upgrades and/or inspections were performed at the Laboratory's Major Petroleum Facility in 2004:

- Internal "out-of-service" API 653 inspections were performed on all six above-ground storage facilities. Any deficiencies identified as part of the inspections were repaired in accordance with best engineering judgment and industry-accepted practices. Copies of the final inspection reports were

Table 3-7. Summary of Chemical and Oil Spill Reports.

Spill No. and Date	Material and Quantity	ORPS Report	Source/Cause and Corrective Actions
04-01 1/10/04	Transmission Fluid 1 gal	No	A BNL employee notified Fire Rescue of a ~1 gal spill of transmission fluid from an employee vehicle in front of Building 488. The spill was on pavement and partially on soil in the area of the parking space. Spill absorbent was placed on the affected areas and BNL's Plant Engineering (EP) personnel collected and containerized the spill absorbent and affected soil, for off-site disposal.
04-06 2/6/04	Ethylene Glycol 1 gal	Yes* (CH-BNL-BNL-2004-0001)	A BNL employee was driving westbound on Princeton Avenue (unpaved portion) after completing a sampling event. The employee slowed to ~ 25 mph and applied the brake to enter a sharp curve. Due to unseen ice on the roadway, the employee was unable to steer the vehicle and it slid directly into a tree resulting in a spill of ~ 1 gal of antifreeze. Spill absorbent was placed on the affected areas and EP personnel collected and containerized the spill absorbent for off-site disposal.
04-08 2/27/04	Unknown Oil 1 gal	No	BNL employees performing a weekly flow chart exchange at recharge basin HZ noticed a darkening of the soil in two areas. Because a crane had previously been parked over the area of the spill, it was assumed to be the source. Although the exact material released is unknown, it is assumed to be a type of oil. EP personnel responded and removed the contaminated soil for off-site disposal.
04-12 3/1/04	Engine Oil 0.5 gal	No	An empty 5-gal container with an open nozzle was found on the grass in front of Building 919B. The manufacturer's label read "Black Bear Company Inc. Motor Oil." Grass and soil around the container had black stains. The contaminated grass and soil were excavated until no visible oil-stained soil and no residual petroleum odors remained. Approximately 2.5 ft ³ of soil was removed by EP personnel for off-site disposal.
04-14 3/8/04	Ethylene Glycol 1 gal	Yes* (CH-BH-BNL-PE-2004-0001)	During repair of the heater block on the emergency generator for Building 488, EP personnel reported a spill of ~ 1 gal (4 lb.) of a 50/50 mix of ethylene glycol and water onto the lower platform, concrete pad, and nearby soil. A deteriorated cooling system hose caused the spill. EP personnel used spill absorbent and containerized it along with the affected soil for off-site disposal.
04-17 3/23/04	Mineral Oil 2 gal	No	Near Building 919, a primary bushing on a transformer (# 912-TRNF-170, 631-5-11) released ~2 gal of mineral oil onto the concrete pad and into the adjacent rocky soil. EP personnel discovered the spill during a routine inspection. They removed the contaminated soil and rock ballast, and containerized it for off-site disposal.
04-18 3/24/04	Mineral Oil 1 gal	No	During routine transformer inspection, a leaking gauge was discovered. EP personnel immediately repaired the leaking gauge fitting and put spill absorbent on the concrete below. They removed the stained rock along with the spill absorbent for off-site disposal.
04-19 3/23/04	Compressor Oil 10 gal	No	The refrigeration compressor in Building 902 shut down. When Cryogenic Group personnel investigated, they discovered that a failed seal on the compressor had released ~ 10 gal of oil to the building. The room had been equipped with an angle iron berm to prevent the release of oil to the outdoors in the event of such an incident. The berm proved to be better than 95 percent effective, with some minor oil weeps evident along the building edge. These were resealed to prevent future releases. Cryogenic Group personnel applied several bags of spill absorbent, which was containerized for off-site disposal.

(continued on next page)

Table 3-7. Summary of Chemical and Oil Spill Reports (continued).

Spill No. and Date	Material and Quantity	ORPS Report	Source/Cause and Corrective Actions
04-22 4/8/04	Transmission Fluid 1 cup	No	A privately owned vehicle had transmission failure and released transmission fluid on the asphalt just east of the Upton/Cornell intersection. Due to the early morning traffic and for safety reasons, the vehicle was moved to the grassy soil beside the road. This resulted in a release of ~ 8 oz. of fluid to soil. Spill absorbent was placed under the vehicle and on the affected soil. EP personnel cleaned the spill and removed the contaminated soil for off-site disposal.
04-24 4/26/04	Transformer Oil 19 gal	Yes* (CH-BH-BNL-PE-2004-0003)	During a rainstorm, an EP employee noticed an oily sheen on Bell Ave., south of Building 452 and found two transformers knocked over. One transformer had lost all its contents (15 gal) and the second transformer lost ~ 4 gal. Oil had crossed the road and entered the storm drain. Fire Rescue diked the storm drains and laid down oil absorbent, but an oil sheen was evident on the stormwater run-off channel adjacent to Grove St. Placing an oil absorbent boom across the channel prevented discharge to a wetland area south of Grove St. The booms were changed several times while the spill was remediated. Analysis of the oil showed it to be contaminated with PCBs. Cleanup was conducted following EPA requirements. Closeout of the incident is pending.
04-25 4/28/04	Cooling Water (Activated) 260 gal	No	The BLIP Target vessel contains ~ 300 gal of cooling water that routinely becomes activated through use. Due to localized Linac beam drift, a beam window flange on this vessel failed, allowing a ~ 260 gal release of cooling water to secondary containment (the outer vessel). The contained cooling water was pumped into US DOT-approved containers for proper off-site disposal. There were no measurable releases of cooling water to the environment and the spilled radionuclide inventory did not exceed CERCLA or State reportable quantities; the spill to containment was deemed nonreportable to EPA and NYSDEC. Because the amount of water spilled into secondary containment exceeded 5 gal, the spill was reportable to SCDHS.
04-26 5/6/04	Diesel fuel 0.5 gal	No	An environmental cleanup contractor rented a trailer-mounted diesel-powered centrifugal pump for the Peconic River cleanup project. The pump was staged on a grassy area near the worksite. An increase in daytime temperature caused expansion in the full fuel tank, releasing ~ 0.5 gal of fuel. The contractor put down adsorbent pads and a 5-gal container to capture the liquids coming from the fuel tank, but some had already contacted the grass below. The contractor removed the affected grass and any soil that had traces (odor or visual) of fuel. These materials were containerized and disposed of off-site.
04-28 5/8/04	Cooling Water (activated) 280 gal	No	See Spill No. 04-25 for details, as this spill was identical. Activated water was again removed from the secondary containment structure and transferred to DOT-approved containers for off-site disposal. After this incident and an extensive investigation, the cause of the beam drift was identified and additional equipment and safeguards were put in place to prevent recurrence.
04-31 5/17/04	Ethylene Glycol 1 gal	Yes* (CH-BH-BNL-PE-2004-0004)	After turning onto South Harvard St., the operator of a forklift (#109917) realized that a mechanical problem had occurred and stopped on the edge of the road across from Building 479. Inspection revealed a failed water pump. Approximately 1 gal of an ethylene glycol and water mix had been released to the roadway and nearby soil. Absorbent pads were immediately put under the forklift. The forklift was taken for repair and the affected soil was removed for off-site disposal.
04-32 5/20/04	Hydraulic Fluid 2 pints	No	An environmental contractor for the Peconic River cleanup was using an excavator to remove surface sediment from the riverbed. Failure of an o-ring on the hydraulic system of the excavator resulted in a loss of hydraulic fluid to a 20 x 5 ft. section of the riverbed. The excavator was immediately moved over the adjacent roadway onto plastic, and absorbent material was placed below it to catch any leaking fluid. Sand bags were placed in the riverbed to prevent the introduction of more water to this section, and multiple absorbent booms were used to remove the 2 pints of fluid released. The booms were containerized for proper disposal. During a follow-up inspection by NYSDEC, the following conditions were placed on the restoration project work in the Peconic River. 1) To help prevent a release of petroleum from diesel/gasoline powered dewatering pumps, a secondary containment system was employed and properly maintained under all pumps at all times. 2) To help contain a release and prevent future impacts, an absorbent boom was pre-deployed at the downstream dewatering pump discharge point at all times and regularly inspected, maintained, and changed as necessary. 3) All proactive measures were to be implemented immediately, remain in place, and become part of the Spill Prevention Plan through project completion.
04-35 6/1/04	Hydraulic Fluid 1 gal	No	A loose hose fitting from a hydraulic cylinder of a 30-ton Terex dump truck released ~ 1 gal of hydraulic fluid onto soil. Absorbent pads were immediately placed on the spill area. The top layer of soil where the spill occurred was removed and placed on plastic sheeting. The soil was containerized for off-site disposal.

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CHAPTER 3: COMPLIANCE STATUS

Table 3-7. Summary of Chemical and Oil Spill Reports *(continued)*.

Spill No. and Date	Material and Quantity	ORPS Report	Source/Cause and Corrective Actions
04-37 6/9/04	Hydraulic Fluid < 1gal	No	A vacuum pump has an exhaust leading out of the rear of Building 1005E. An in-line mist eliminator is part of the system to capture any residual oil that accumulates during exhausting. The mist eliminator had become oversaturated during operation and released less than 1 gal of oil through the exhaust. The oil saturated the soil underneath the exhaust point. EP personnel remediated the area by collecting and containerizing the oily soil for off-site disposal.
04-43 7/1/04	Hydraulic Fluid 0.25 gal	No	A contractor-owned excavator struck a tree branch, rupturing a hydraulic line. Less than 0.25 gal of hydraulic fluid spilled onto the soil near Building 815. Absorbent pads were immediately placed on the spill area by Fire Rescue. The soil was removed by the contractor and placed in a 55-gal drum. BNL arranged for off-site disposal of the soil.
04-44 7/8/04	Diesel Fuel < 1 gal	No	A BNL employee walking in the area of the Peconic River cleanup noticed soil discoloration beneath the trailer carriage of a portable diesel generator that was being used by a contractor as a power source. The employee alerted Fire Rescue to the spill, which was probably caused by expansion of fuel in the generator tank after it had been filled. Contractor personnel dug out a 3- x 5-ft. area under the trailer carriage, removing all visibly contaminated soil. The waste was stored in large polyethylene bags and transported to a staging area for transfer to 55-gal drums. BNL arranged for off-site disposal of the soil.
04-45 7/12/04	Hydraulic Fluid < 0.5 cups	No	An excavator that had been used in the Peconic River cleanup was on the east firebreak road awaiting return to the leasing company. A BNL employee passing by noticed a small stained area in the sand near the base of the unit, and notified Fire Rescue. Absorbent pads were used to clean the excavator undercarriage stained from the leaking hydraulic line. The contaminated soil was shoveled into a 3-gal pail for proper off-site disposal. The excavator was returned to the leasing company later that day.
04-48 7/20/04	Hydraulic Fluid 1 pint	No	During the Peconic River cleanup, a contractor-operated excavator released hydraulic fluid into ponded Peconic River water (in a dewatered area) and onto sediment. The spill was caused by the failure of a rubber o-ring on a hydraulic line. Booms were placed on the ponded water and pads were put below the leaking hydraulic line. The o-ring was replaced after the line was fully drained. Pads, booms, and associated debris were bagged and repacked into drums for off-site disposal.
04-56 9/16/04	Fuel Oil 4 gal	No	During the planned removal of an Underground Storage Tank (UST) on the north side of Building T-87, several small holes were observed on the side of the tank. A Sanitary Engineer from SCDHS observed the tank's removal. It was set aside and the excavation was inspected. SCDHS provided oversight during the removal of contaminated soil, checking for contamination (sniff and water sheen) until clean soil was encountered. A total of ~ 4 yd ³ of soil was removed and disposed of. SCDHS determined that all contaminated soil had been removed and that end point samples were not necessary. The excavation was backfilled.
04-57 9/17/04	Fuel Oil 65 gal	Yes* (CH-BH-BNL-PE-2004-0005)	During a planned UST removal on the south side of Building 244, at least one dime-sized hole was observed on the bottom of the tank. A SCDHS Sanitary Engineer observing the tank's removal also oversaw the removal of contaminated soil, checking it for contamination (sniff and water sheen) until the depth of the excavation (~ 15 ft) and proximity of the building made further soil removal unwise. One soil sample collected from the bottom of the excavation confirmed that not all of the contamination had been removed, but a Geoprobe investigation of the tank area showed no impacts above state and county action levels. A total of approximately 40 yd ³ of soil was removed from the excavation for off-site disposal.
04-58 9/24/04	Hydraulic Fluid < 1 pint	No	Hydraulic fluid was observed leaking from a manlift as it was parked along the railroad track. Inspection of the unit revealed the hydraulic fluid was leaking from a twisted ¾-in. hydraulic line. Plastic was placed beneath the manlift and contractor personnel scraped up the contaminated soil beneath the manlift and along the railroad. Contaminated soil and absorbent rags that were used to clean the chassis of the manlift were placed in containers for off-site disposal. The damaged manlift was transported off site for repairs.
04-59 9/22/04	Fuel Oil 90 gal	Yes* (CH-BH-BNL-PE-2004-0005)	During a planned UST removal on the south side of Building 339, significant contamination was discovered near the tank's fill and vent lines. In addition, at least one small hole was observed on the bottom of the tank. SCDHS and NYSDEC observed tank removal and inspected the excavation, examining the soil for contamination (sniff and water sheen) until the depth of the excavation (~ 14 ft) and proximity of the building prevented further soil from being removed. It appeared that clean soil was reached on the bottom and sidewalls of the excavation. To confirm this, three soil samples were collected and analyzed for volatile and semivolatile organic compounds. Analytical results showed remaining soils to be less than state and county action levels. In total, ~ 50 yd ³ of soil were removed and properly disposed.

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Table 3-7. Summary of Chemical and Oil Spill Reports (concluded).

Spill No. and Date	Material and Quantity	ORPS Report	Source/Cause and Corrective Actions
04-60 9/27/04	Oil/Degreaser < 1 cup	No	Oil sheen was observed on water run-off near Buildings 326 and 423, the EP Heavy Equipment Mechanic Operator Shop. The cause of the oil sheen was determined to be residual oil (hydraulic or diesel) on the frame of a New Holland skid steer that was being washed down as part of a preventive maintenance action. The water runoff had made its way to the catch basin on the southeast corner of Building 326 that discharges into the woods south of the building. Absorbent pads and an absorbent sock were used to contain contaminated runoff and absorb residual water/oil. The skid steer's oil, hydraulic, and coolant reservoirs were checked and there was no noticeable loss of fluids. Therefore, residual oils on the frame of the unit were seen as the likely source of the sheen. Remedial actions included using a wet vacuum to suction the small pool of water containing the residual oil and degreaser (Simple Green). The bottom of the catch basin was cleaned with absorbent pads and the contaminated soil at the point of discharge in the wooded area was manually excavated by EP personnel. Analytical results on soil samples showed no exceedance of county action levels. All contaminated absorbents and soils were disposed of off site.
04-64 10/12/04	Diesel Fuel ~ 1 pint	No	While EP personnel were preparing equipment for the winter, they discovered that one of the smaller farm tractors, primarily used for snow clearing, had leaked a small amount of diesel fuel on the ground. The date and time of the spill is unknown, but the cause of the leak was most likely from fuel in the tank expanding during the summer. The spill site was cleaned up. Most of the contamination was concentrated in the grass and leaves below the tractor. Approximately 1 to 2 in. of impacted soil were removed and contaminated material was collected for off-site disposal.
04-66 10/22/04	Ethylene Glycol solution 1 gal	Yes* (CH-BH-BNL-BNL-2004-0021)	A BNL employee was transferring a 5-gal plastic container of 50/50 ethylene glycol and water to a laboratory in Building 815. The container was transported in the bed of a pick-up truck and in secondary containment. However, when the container was lifted by the handle, it ruptured, releasing 1 gal of the glycol mixture. Most landed on the concrete pad and was contained with spill absorbent. A small quantity spilled onto the cab of the truck and onto the ground. It is estimated that < 1 lb (i.e., < 1/2 lb glycol) spilled onto soil. EP personnel cleaned up the material and containerized it for off-site disposal.
04-72 12/10/04	Engine Oil 2 – 3 quarts	No	Contractor workers noticed a fuel film on soil after their contract fuel company delivered fuel to their equipment. The contractor suspected the source was the departing fuel truck and stopped the truck at the corner of Brookhaven Ave. and Power Line Rd. He confirmed that the fuel delivery truck was leaking motor oil and placed absorbent pads under the truck to capture any further drips. A light oil film was observed on the soil in several locations around the truck and a more substantial area (~2 x 3 ft) was observed on the soil adjacent to the truck. The contractor cleaned up the spill and BNL disposed of the contaminated material.
04-73 12/17/04	Oil/Water mixture 120 gal	No	BNL staff drained and replenished the Citranox tank in the Central Cleaning facility. Approximately 275 gal of cleaning solution were transferred to the Coolant Recycling Facility for processing in the Water Eater. The operator of the Coolant Recycling Facility began processing the Citranox Solution to evaporate the water at ~ 1530 hrs using the Water Eater autofill cycle, then left the facility. A considerable volume of tramp oil was already in the Water Eater tank from a batch of Blasocut 2000 Coolant that had been previously processed. As the Citronox was heated to 212 °F, the water in solution began to boil. The boiling liquid caused a water/oil foam to form and spill over the top of the tank. When this foam hit the cold steel floor in the building, it condensed, producing steam. After liquid in the tank dropped below the autofill low-level line, the pump automatically activated, causing more Citronox to be dispensed into the tank, repeating the cycle. Eventually, enough steam was produced to set off a heat detector that, in turn, activated an alarm in Building 479 to alert Fire Rescue. They immediately responded, as did the site supervisor on duty. When the door to Building 495 was opened, there was ~ 3 in. of oil/water on the floor. Power to the Water Eater tank was cut. All of the oil/water was fully contained within the building's secondary containment. Using a wet vacuum, workers recovered ~ 130 gal of oil/water and placed it in drums for off-site disposal.

Notes:

* Release is reportable to DOE under the requirements of DOE Order 231.1A, Occurrence Reporting and Processing.
 BLIP = Brookhaven Linear Isotope Producer
 CERCLA = Comprehensive Environmental Response, Compensation and Liability Act
 DOT = Department of Transportation

NYSDEC = New York State Department of Environmental Conservation
 PCBs = PolyChlorinated Biphenyls
 SCDHS = Suffolk County Department of Health Services
 UST = Underground Storage Tank
 PVC = Polyvinyl chloride

Table 3-8. Summary of Other BNL Environmental Occurrence Reports.*

<p>ORPS ID: CH-BH-BNL-BNL-2004-0002</p> <p>The New York State Department of Environmental Conservation (NYSDEC) issued a Notice of Violation for deficiencies noted during a January 5 unannounced inspection of BNL's Hazardous Waste Program. Three administrative issues were identified during this inspection, all related to the labeling of hazardous/universal waste.</p>	<p>Date: 2/13/04</p> <p>Status: Closed. All corrective actions have been completed.</p>
<p>ORPS ID: CH-BH-BNL-BNL-2004-0008</p> <p>A small volume of radiologically contaminated water leaked from a transport container being used at the Brookhaven Graphite Research Reactor (BGRR) decommissioning project. Although no Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or State reporting limits were exceeded, the ORPS report was issued due to transportation concerns.</p>	<p>Date: 5/05/04</p> <p>Status: Closed. All corrective actions have been completed.</p>
<p>ORPS ID: CH-BH-BNL-BNL-2004-0012</p> <p>A package containing radioactive waste en route to Envirocare of Utah was found leaking at a rest stop in Western Pennsylvania. Radiological Control technicians from the Susquehanna Power Plant conducted smear surveys of the container and liquid. No contamination was evident on the exterior of the package or in the collected water. It was determined that rainwater had accumulated in a welded support channel that subsequently leaked to the bed of the trailer.</p>	<p>Date: 6/29/04</p> <p>Status: Closed. There were no corrective actions identified.</p>
<p>ORPS ID: CH-BH-BNL-PE-2004-0013</p> <p>A package containing radioactive waste en route to Envirocare of Utah was found to be leaking during an inspection by the transporter during a stop in Green River, Wyoming. The package contained low-level radioactive brine from a geothermal well that had been solidified using a commercial solidification agent. Though no active leak was evident during inspection by the local enforcement agency, smears collected by DOE's Radiological Assistance Program confirmed low-level detections of radiological contaminants on the truck trailer. The package was repaired and overpacked to prevent further release and sent on to Envirocare for disposal. The truck trailer was cleaned and released. There was no detectable contamination on the road beneath the trailer. Evaluation of the incident revealed that the spill resulted from insufficient solidification of the waste, which resulted in leakage through the liners. Corrective Actions include performance of benchtop testing of all solidification processes and performance testing of liners to ensure that they are watertight.</p>	<p>Date: 7/28/04</p> <p>Status: Open. Two corrective actions remain open.</p>
<p>ORPS ID: CH-BH-BNL-BNL-2004-0016</p> <p>On 9/4/04, 37 train cars derailed near Utica, New York due to a track problem. One of the railcars contained nonhazardous, nonradioactive soils excavated as part of the Peconic River project that were en route to a disposal facility near Niagara Falls, New York. The transportation company assumed all responsibility for repackaging the waste and shipping it to the disposal facility. BNL staff confirmed that all waste was repackaged and shipped.</p>	<p>Date: 9/10/04</p> <p>Status: Closed. All corrective actions have been completed.</p>
<p>ORPS ID: CH-BH-BNL-PE-2004-0023</p> <p>A graduate student working in the Medical Department disposed of water potentially containing trace levels of FI-18 to a sink drain. This was a violation of the posted Radiological Work Permit and resulted in issuance of a Radiological Awareness Report. Investigation showed there was no release of radionuclides.</p>	<p>Date: 11/01/04</p> <p>Status: Closed. All corrective actions have been completed.</p>
<p>ORPS ID: CH-BH-BNL-BNL-2004-0027</p> <p>On 12/7/04, NYSDEC conducted a second inspection of BNL's Hazardous Waste Program and issued a second Notice of Violation for the mishandling of universal wastes. Specifically, waste fluorescent light bulbs were not stored in proper containers, and were not labeled in accordance with universal waste rules.</p>	<p>Date: 12/23/04</p> <p>Status: Closed. All corrective actions have been completed.</p>

*All events reportable under the Occurrence Reporting and Processing System (ORPS), established by the requirements of DOE Order 231.1A.

- submitted to NYSDEC and SCDHS in May.
- Tanks No. 5 and No. 6 were placed back in service in May after completion of upgrades to the fuel oil piping and cathodic protection electrical circuits.
- An existing 60,000-gallon No. 2 fuel oil tank (Tank No. 12) was emptied and all piping was removed, in preparation for placing the tank permanently out of service.
- The 2004 NYSDEC annual inspection was conducted in August. The inspection noted four conditions that required corrective action: one related to the management of vegetative growth in the secondary containment berms at Building 610, one related to the remote high-level alarm and tank gauge

system inside the Central Steam Facility Steam Plant Control Room, one for peeling and blistering paint on the roof plates and piping associated with Tanks No. 5 and No. 6, and one related to a previously repaired failure of the concrete containment area at Building 326. All conditions are being corrected in accordance with NYSDEC directives.

3.8.5 Chemical Bulk Storage

Title 6 of the *Official Compilation of the Codes, Rules and Regulations of the State of New York* (NYCRR), Part 597, requires registration with NYSDEC of all aboveground tanks larger than 185 gallons and all underground tanks that store specific chemical substances. BNL holds a Hazardous Substance Bulk Storage Registration Certificate for eight tanks. Seven of the tanks store potable water treatment chemicals (sodium hydroxide and sodium hypochlorite) and one tank stores gallium trichloride, formerly required in physics experiments. The tanks range in size from 200 to 1,200 gallons. These tanks are also regulated under *Suffolk County Sanitary Code Article 12* (SCDHS 1993) and are managed in accordance with BNL procedures designed to conform to Suffolk County requirements.

NYSDEC conducted an inspection of the Chemical Bulk Storage (CBS) facilities in August 2004. During this inspection, only one issue required corrective action: an existing floor drain in the Building 624 hypochlorite storage room must be plugged during normal operations to prevent an uncontrolled release of product. This issue was corrected in accordance with the NYSDEC directive.

3.8.6 County Storage Requirements

Article 12 of the Suffolk County Sanitary Code, administered by SCDHS, regulates the storage and handling of toxic and hazardous materials in aboveground or underground storage tanks (USTs), drum storage facilities, piping systems, and transfer areas. Article 12 specifies design criteria to prevent environmental impacts resulting from spills or leaks. It also specifies administrative requirements, such as

identification, registration, and spill reporting procedures. In 1987, BNL entered into a voluntary Memorandum of Agreement (MOA) with SCDHS, in which DOE and BNL agreed to conform to the environmental requirements of Article 12.

Currently, BNL has approximately 430 active storage facilities listed in the Suffolk County Tanks Database. Also included in the county database are another 24 storage facilities associated with environmental restoration activities conducted under the CERCLA program; these facilities are not regulated under Article 12. BNL storage facilities listed in the database include those storing fuel (some of which are also regulated under the MPF license), wastewater, and chemicals, as well as storage facilities used to support Laboratory research.

BNL has an ongoing program to upgrade or replace existing storage facilities and to meet with representatives of SCDHS to ensure that the information provided for all registered storage facilities is accurate and that new or modified storage facilities are designed and reviewed for full conformance with Article 12 regulations.

In 2004, a project was funded to remove and replace the final three unprotected, single-walled USTs at BNL. The USTs were successfully removed from the ground in September 2004 and replaced with three new aboveground storage tanks that meet the Article 12 minimum design standards. In addition, BNL prepared design submittals and project descriptions, and coordinated several inspections with SCDHS that resulted in the Laboratory receiving approximately 75 "Permits to Operate." These permits indicate that the registered storage facility was approved, inspected, and built according to the requirements of Article 12.

3.9 RESOURCE CONSERVATION AND RECOVERY ACT

RCRA regulates hazardous wastes that, if mismanaged, could present risks to human health or the environment. The regulations are designed to ensure that hazardous wastes are managed from the point of generation to final disposal. In New York State, EPA delegates

the RCRA program to NYSDEC, with EPA retaining an oversight role. BNL is considered a large-quantity generator because it may generate greater than 1,000 kg of hazardous waste in a month and has a RCRA permit to store hazardous wastes for 1 year before shipment off site to licensed treatment and disposal facilities. BNL has a number of satellite accumulation and 90-day storage areas.

NYSDEC conducted two inspections of BNL hazardous waste management operations in 2004, one in January and one in December. A Notice of Violation (NOV) was issued as a result of each inspection. The January NOV identified several waste batteries and a bag of waste solder that were not properly labeled. The December NOV identified some waste fluorescent light bulbs being managed as universal waste that were not properly packaged and labeled. In each instance, the violations were corrected to the satisfaction of NYSDEC before the conclusion of the inspection, thus requiring no further actions by BNL.

Mixed wastes are materials that are both hazardous (under RCRA guidelines) and radioactive. The Federal Facilities Compliance Act (FFCA), issued in 1992, requires that DOE work with local regulators to develop a site treatment plan to manage mixed waste. Development of the plan has two purposes: to identify available treatment technologies and disposal facilities (DOE or commercial) that are able to manage mixed waste produced at federal facilities, and to develop a schedule for treating and disposing of these waste streams.

BNL updates the *BNL Site Treatment Plan (1997)* annually and submits it to NYSDEC. The updated plan documents the current mixed waste inventory and describes efforts undertaken to seek new commercial treatment and disposal outlets for various waste streams. Treatment options for all of the mixed waste now in storage have been identified, and most of the current inventory was shipped off site for treatment and disposal in 2004. BNL expects to ship the remainder of those mixed wastes in storage covered by the plan in early 2005. This will enable BNL to terminate its consent order with NYSDEC pertaining to this plan and

continue to manage mixed wastes within its permitted time frame of 1 year.

3.10 POLYCHLORINATED BIPHENYLS

The storage, handling, and use of PCBs are regulated under the Toxic Substance and Control Act (TSCA). Capacitors manufactured before 1970 that are believed to be oil filled are handled as if they contain PCBs, even when the existence of PCBs cannot be verified through an investigation of the manufacturer's records. All equipment containing PCBs must be inventoried, except for capacitors containing less than 3 pounds of dielectric fluid and items with a concentration of PCB source material of less than 50 parts per million. The PCB inventory is updated by July 1 of each year. All PCB-containing articles or PCB-contaminated equipment must be labeled. BNL responds to any PCB spill in accordance with standard emergency response procedures. BNL was in compliance with TSCA requirements in 2004 and reduced its PCB inventory by approximately 42 percent, including the draining of a 100-gallon regulator in Building 901 and disposal of several large capacitors from the Collider-Accelerator Department.

3.11 PESTICIDES

The storage and application of pesticides (insecticides, rodenticides, herbicides, and algicides) are regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Pesticides at BNL are used to control undesirable insects, mice, and rats; to control bacteria in cooling towers; and to maintain certain areas free of vegetation (e.g., around fire hydrants and inside secondary containment berms). Insecticides are also applied to agricultural research fields and in greenhouses on site. Herbicide use is minimized wherever possible (e.g., through spot treatment of weeds). All pesticides are applied by BNL-employed New York State-certified applicators. By February 1, each applicator files an annual report with NYSDEC detailing insecticide, rodenticide, algicide, and herbicide use for the previous year. BNL was in full compliance with FIFRA requirements in 2004.

3.12 WETLANDS AND RIVER PERMITS

As noted in Chapter 1, portions of the BNL site are situated on the Peconic River floodplain. Portions of the Peconic River are listed by NYSDEC as scenic under the Wild, Scenic, and Recreational River Systems Act. BNL also has six areas regulated as wetlands and a number of vernal (seasonal) pools. Construction or modification activities performed within these areas require permits from NYSDEC.

Activities that could require review under the BNL Natural and Cultural Resource Management Programs are identified during the NEPA process (see Section 3.3). In the preliminary design stages of a construction project, design details required for the permit application process are specified. These design details ensure that the construction activity will not negatively affect the area, or if it does, that the area will be restored to its original condition. When design is near completion, permit applications are filed. During and after construction, BNL must comply with the permit conditions.

In 2004, four projects were permitted under this program, all ongoing from 2003. These projects included paving the parking lots at Buildings 1002 and 1004, and constructing a new recharge basin, a storage facility at the Alternating Gradient Synchrotron, and ancillary structures at Buildings 1007 and 1009 (not begun in 2004 and likely to be canceled). Formal closure notification for the paving project was filed with NYSDEC in July. Final photos and completed project notifications for the other finished projects will be filed with NYSDEC in 2005 to close these permits.

3.13 ENDANGERED SPECIES ACT

In 2003, BNL updated its list of endangered, threatened, and species of special concern (see Table 6-1 in Chapter 6). An additional species was added to the list in 2004. The worm snake (*Carphophis amoenus*), a species of special concern, was found within the central moist forest area of the Laboratory.

Although the eastern tiger salamander is no longer the only state endangered species found at BNL, it is the most notable and best-studied species on site. Eastern tiger salamanders are

listed in New York State as endangered because populations have declined due to habitat loss through development, road mortality during breeding migration, introduction of predatory fish into breeding sites, historical collection for the bait and pet trade, water level fluctuations, pollution, and general disturbance of breeding sites. BNL finalized the *Natural Resource Management Plan (BNL 2003)* (NRMP) in December 2003 and began immediate implementation. One component of the new plan formalizes the strategy and actions needed to protect 22 confirmed eastern tiger salamander breeding locations identified at BNL. The strategy includes identifying and mapping habitats, monitoring breeding conditions, improving breeding sites, and controlling activities that could negatively affect breeding. A multi-year study of three ponds was begun in 2004 to gain a better understanding of the habitat needs and movements of this salamander.

The banded sunfish and swamp darter are found in the Peconic River drainage areas at BNL. Both are listed as threatened species within New York State because eastern Long Island has the only known remaining populations of these fish in New York. Measures taken or being taken by BNL to protect the banded sunfish and swamp darter and their habitat include the following:

- Eliminating, reducing, or controlling pollutant discharges
- Upgrading the STP to reduce nitrogen loading in the Peconic River (completed in 1998)
- Monitoring populations and water quality
- Maintaining adequate flow to the river to enable the fish to survive drought
- Minimizing disturbances to the river and adjacent banks

Of the three butterfly species found at BNL that are endangered, threatened, or of special concern, both the frosted elfin and persius duskywing depend on lupine, a wildflower in the pea family. In the past, a single area of lupine existed on BNL grounds. This habitat still exists and it is assumed that the butterflies are still present. The mottled duskywing prefers New Jersey Tea plant, which has not been

found at BNL. Management of habitat and surveys for the three butterflies has been added to the BNL natural and cultural resource management programs.

BNL also has 12 species that are listed as species of special concern. Such species have no protection under the state endangered species laws, but may be protected under other state and federal laws (e.g., Migratory Bird Treaty Act). New York State monitors species of special concern and manages their populations and habitats, where practical, to ensure that they do not become threatened or endangered. Species of special concern found at BNL include the mottled duskywing butterfly, marbled salamander, eastern spadefoot toad, spotted turtle, eastern box turtle, eastern hognose snake, worm snake, horned lark, whip-poor-will, vesper sparrow, grasshopper sparrow, and Cooper's hawk. The management efforts for the eastern tiger salamander also benefit the marbled salamander. At present, no additional protective measures are planned for the eastern box turtle or spotted turtle, as little activity occurs within their known habitat at BNL. Radio telemetry work on the spotted turtle was carried out in 2004 and a basic understanding of their movements and habitat needs was developed. A radio telemetry study on the eastern hognose snake continued in 2004, resulting in greater understanding of this species' habitat needs and its movement between habitats. BNL continues to evaluate bird populations as part of the management strategy outlined in the NRMP. Data concerning species of special concern are used appropriately in making management decisions regarding these species. In addition to the bird species mentioned above, 18 other bird species listed as species of special concern and two federally threatened species have been observed during spring and fall migrations.

BNL has 20 plant species protected under state law. One is an endangered plant, the crested fringed orchid; two are threatened plants, the stiff goldenrod and stargrass; and two are rare plants, the narrow-leaved bush clover and long-beaked bald-rush. The other 15 species are considered to be exploitably

vulnerable, meaning that they may become threatened or endangered if factors that result in population declines continue. These plants are currently sheltered at BNL due to the large areas of undeveloped pine barren habitat on site. Locations of these rare plants must be determined, populations estimated, and management requirements established. Management of protected plants is included in the NRMP. See Chapter 6 for more information.

3.14 EXTERNAL AUDITS AND OVERSIGHT

A number of federal, state, and local agencies oversee BNL activities. In 2004, BNL was inspected by federal, state, or local regulators on 12 occasions. Also in 2004, SCDHS maintained a part-time, on-site staffer who provided day-to-day oversight of BNL activities. In addition to external audits and oversight, BNL has a comprehensive self-assessment program, as described in Chapter 2.

3.14.1 Inspections by Regulatory Agencies

- *Hazardous Waste.* NYSDEC conducted two RCRA/hazardous waste compliance inspections in 2004. Notices of Violation were issued during both inspections for minor administrative deficiencies that were corrected immediately.
- *Air Compliance.* NYSDEC conducted an annual inspection of the Central Steam Facility in March. No issues were identified during this inspection.
- *Potable Water.* SCDHS conducts sampling and makes annual inspections of the BNL potable water system to ensure that facilities are maintained. There were no issues identified in 2004. All sample results were within DWS, except for iron, which occurs naturally in some of the wells. As noted in Section 3.7.1, BNL treats the drinking water supply to remove iron before distribution.
- *Sewage Treatment Plant.* SCDHS conducts quarterly inspections of the BNL STP to evaluate operations and sample the effluent. In 2004, no performance or operational issues were identified during these inspections. NYSDEC conducts annual inspections of the STP. In 2004, no issues were identified.

Table 3-9. Existing Agreements and Enforcement Actions Issued to BNL, with Status.

Number	Title	Parties	Effective Date	Status
Agreements				
No Number.	Suffolk County Agreement	SCDHS, DOE, and BNL	Originally signed on 9/23/87	This Agreement was developed to ensure that the storage and handling of toxic and hazardous materials at BNL conform with the environmental and technical requirements of Suffolk County codes.
No Number.	FFCA on Mixed Wastes	NYSDEC and DOE	1992 (updated annually)	The Federal Facilities Compliance Act (FFCA) requires that a site treatment plan to manage mixed wastes be written and updated annually. BNL is in compliance with this requirement.
II-CERCLA-FFA-00201	Federal Facility Agreement under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Section 120 (also known as the Interagency Agreement or "IAG" of the Environmental Restoration Program).	EPA, DOE, and NYSDEC	05/26/92	Provides the framework, including schedules, for assessing the extent of contamination and conducting the BNL cleanup. Work is performed either as an Operable Unit or a Removal Action. The IAG integrates the requirements of CERCLA, Resource Conservation and Recovery Act (RCRA), and the National Environmental Policy Act (NEPA). All IAG-scheduled milestones were met in 2004.
Enforcement Actions				
No Number.	Notice of Violation–RCRA	NYSDEC	02/13/04	A Notice of Violation was issued for administrative (labeling) deficiencies identified during the 2004 annual hazardous waste compliance inspection conducted by NYSDEC.
No Number.	Notice of Violation–RCRA	NYSDEC	12/23/04	A Notice of Violation was issued for universal waste handling deficiencies identified during a December 2004 hazardous waste compliance inspection conducted by NYSDEC.

Notes:

NYSDEC = New York State Department of Environmental Conservation

SCDHS = Suffolk County Department of Health Services

- *Recharge Basins.* As part of SCDHS oversight, recharge basins and other SPDES outfalls are inspected periodically. In 2004, SCDHS inspected the outfalls in March and collected samples during the assessment. No issues were identified.
- *Major Petroleum Facility.* The MPF is inspected annually by NYSDEC. An inspection was conducted in July 2004. See Section 3.8.4 for a discussion of this inspection.
- *Chemical Bulk Storage Facilities.* The CBS facilities are inspected periodically by NYSDEC. This inspection was conducted in July 2004. See Section 3.8.5 for a discussion of this inspection.

3.14.2 Inspections by DOE

DOE Headquarters (EH-10) and the Chicago Operations Office did not conduct assessments

of the Laboratory's environmental programs in 2004. However, the DOE Brookhaven Site Office (BHSO) continued to oversee BNL programs and observed programmatic assessments of the liquid effluents management program, the transfer of Facility Review Disposition Project issues, and an internal hazardous waste compliance assessment. The results of these three assessments are summarized in the paragraphs below.

3.14.2.1 Liquid Effluents Self-Assessment

From May 3 to May 21, 2004, the Environmental and Waste Management Services Division (EWMSD) conducted a self-assessment of the Laboratory's wastewater management practices, compliance with federal and state regulatory requirements, and past performance of the SPDES program. This assessment was conducted as part of the EWMSD self-assess-

ment program and included DOE BHSO observation. The last liquid effluents assessment was conducted in 2001.

The assessment reviewed liquid effluent management practices across most departments and divisions and included documentation review, data verification (routine and nonroutine discharge databases), field observations of liquid discharge processes, and interviews with line personnel. The assessment found three Noteworthy Practices, two Nonconformances, six Observations, and five Opportunities for Improvement. None of the items presented immediate threats to the environment, and corrective actions were implemented to prevent potential releases to the environment and to correct potential noncompliance issues.

3.14.2.2 Hazardous Waste Management

From July 7 to August 5, 2004, EWMSD conducted a self-assessment of the Laboratory's hazardous waste management practices, compliance with federal and state regulatory requirements, and past performance of the RCRA Program. This assessment was conducted as part of the EWMSD self-assessment program and included DOE BHSO observation.

The findings indicated that there were issues throughout the complex with regard to waste labeling, waste characterizations, training, and waste container management. To address these findings and identify root causes for repeat violations, an interdepartmental team was formed to improve the entire waste management process. The recommendations of the team are scheduled to be published in early 2005.

3.14.2.3 Facility Review Disposition Project – Review of Transferred Issues

In 2004, EWMSD conducted a self-assessment on the current status of the 332 transferred issues included in the Facility Review Disposition Project. The primary purposes of the assessment were to ensure project awareness/ownership of the transferred issues and to determine whether any actions had been completed, so they could be officially closed. The assessment revealed that approximately 75 percent (250) of the issues could be closed. The remaining 25 percent were

primarily associated with ongoing CERCLA projects that will remain transferred until the project is completed. In 2004, EWMSD provided SCDHS with documentation justifying the closure of more than 200 of the transferred issues.

3.14.3 Enforcement Actions and Memos

No new consent orders were issued to BNL in 2004. Two Notices of Violation for administrative deficiencies were issued by NYSDEC as a result of the RCRA inspections conducted in January and December (see discussion in Section 3.9). All existing enforcement actions and MOAs are listed in Table 3-9, along with a summary of their status. BNL determined that it has fully complied with the terms and conditions listed in these actions and has submitted supporting documentation to the regulatory agencies. The Laboratory continues to work with the regulators to close these actions as expeditiously as possible.

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Air Quality

Brookhaven National Laboratory (BNL) monitors both radioactive and nonradioactive emissions at several facilities on site to ensure compliance with the requirements of the Clean Air Act. In addition, the Laboratory conducts ambient air monitoring to verify local air quality and assess possible environmental impacts from BNL operations.

During 2004, BNL facilities released a total of 2,711 curies of short-lived radioactive gases. Oxygen-15 and carbon-11 emitted from the Brookhaven Linac Isotope Producer constituted more than 99.8 percent of the site's radiological air emissions.

Since natural gas prices were comparatively higher than residual fuel prices throughout 2004, the Central Steam Facility (CSF) continued to rely on residual fuel to meet the heating and cooling needs of BNL's major facilities. As a result, annual facility emissions of particulate matter, nitrogen oxides, and sulfur dioxide were considerably higher in 2004 than in 1999, when natural gas was the predominant fuel used at the CSF.

4.1 RADIOLOGICAL EMISSIONS

Federal air quality laws and DOE regulations that govern the release of airborne radioactive material include 40 CFR 61 Subpart H: *National Emission Standards for Hazardous Air Pollutants* (NESHAPs)—part of the Clean Air Act, and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. Under NESHAPs Subpart H, facilities that have the potential to deliver an annual radiation dose of greater than 0.1 mrem (1 μ Sv) 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. BNL has one facility that requires continuous monitoring, the Brookhaven Linac Isotope Producer (BLIP). Periodic monitoring is conducted at one active facility, the Target Processing Laboratory (TPL), and two inactive facilities, the Brookhaven Medical Research Reactor (BMRR) and the High Flux Beam Reactor (HFBR). Figure 4-1 indicates the locations of these monitored facilities, and Table 4-1 presents the airborne release data from each of these facilities during 2004. Annual emis-

sions from monitored facilities are discussed in the following sections of this chapter. Also discussed is a fourth inactive facility, the Evaporator Facility, which was periodically monitored in past years. The associated radiation dose estimates are presented in Chapter 8, Table 8-4.

4.1.1 Brookhaven Medical Research Reactor

In August 2000, DOE announced that the BMRR would be permanently shut down due to a reduction of research funding. Until it stopped operating in late December 2000, the BMRR was fueled with enriched uranium, moderated and cooled by “light” (ordinary) water, and was operated intermittently at power levels up to 3 MW, thermal. Air from the interior of the containment building was used to cool the neutron reflector surrounding the core of the reactor vessel. As air was drawn through the reflector, it was exposed to a neutron field, resulting in activation of the argon fraction of the air. This produced argon-41 (Ar-41), an inert, radioactive gas. After passage through the reflector, the air was routed through a roughing filter and a high-efficiency particulate air (HEPA) filter to

Figure 4-1. Air Emission Release Points Subject to Monitoring.

remove any particulate matter. Charcoal filters were also used to remove radioiodines produced during the fission process. Following filtration, the air was exhausted to the atmosphere through a 150-ft stack adjacent to the reactor containment building. This air was continuously monitored for Ar-41 emissions.

After the BMRR stopped operating, continuous Ar-41 monitoring was reduced to periodic, semi-annual monitoring to confirm that radionuclide concentrations remain below detection limits. In 2004, sampling showed there were no detectable emissions of Ar-41 or other radionuclides with building ventilation turned on.

In January 2003, the remaining fuel was removed from the BMRR reactor vessel, eliminating the last significant source for radionuclide emissions to the environment. The sole remaining emission source is evaporation of the cooling water, which contains the radioactive isotope tritium produced by neutron activation when the BMRR operated. In 2004, the release of tritium as tritiated water vapor (HTO) was estimated at 76.3 mCi, based on the concentration of tritium and previously measured decreases in the volume of water. In December 2004, a petition with supporting analytical data and dose calculations was filed with EPA with

the intention to discontinue emissions monitoring at the BMRR.

4.1.2 High Flux Beam Reactor

When the HFBR operated, “heavy” water was used as a neutron moderator and fuel coolant. Heavy water, or D_2O , is water composed of a nonradioactive isotope of hydrogen known as deuterium. When exposed to neutron fields generated inside a reactor vessel, deuterium becomes activated and produces radioactive tritium. Tritiated heavy water from the HFBR system was stored in a spent fuel storage pool. In 1997, a leak in this pool was discovered when a plume of tritiated groundwater was traced back to it. The HFBR was put in standby mode, the pool was pumped out, and the water from the pool was properly disposed of as radioactive waste. The pool was then repaired and double lined, in accordance with Suffolk County Article 12 regulations (SCDHS 1993) and remained empty while the facility was in a standby mode.

The HFBR continued in standby mode until November 1999, when DOE declared that it was to be permanently shut down. Residual tritiated water in the vessel and cooling loops continues

to diffuse into the building’s air through valve seals and other system penetrations, though emission rates are much lower than during the years of operation (Figure 4-2). The increase in emissions that occurred in 2003 was attributed to evaporative losses when tritiated water remaining in the reactor core was pumped out for off-site disposal. In 2004, the downward trend in emissions resumed: the level dropped from 9.0 Ci (the 2003 value) to 3.94 Ci. This downward trend is expected to continue as tritiated water vapor in the HFBR air equilibrates. Sampling frequency continues at 1 week per month.

4.1.3 Brookhaven Linac Isotope Producer

Protons from the Linear Accelerator (Linac) are sent via an underground beam tunnel to the BLIP, where they strike various metal targets. The proton beam activates these metal targets to produce new radionuclides for medical diagnostic tests. The activated metal targets are transferred to the TPL in Building 801 for separation and later shipment to various radiopharmaceutical research laboratories. During irradiation, the targets become hot and

Figure 4-2. High Flux Beam Reactor Tritium Emissions, Ten-Year Trend (1995–2004).

are cooled by a continuously recirculating water system. The cooling water also becomes activated during the process, producing secondary radionuclides. The most significant of these radionuclides are oxygen-15 (O-15) and carbon-11 (C-11). Both of these isotopes are released as gaseous, airborne emissions through the facility's 33-ft stack.

In 2004, the BLIP operated over a period of 11 weeks. During this period, 680 Ci of C-11 and 2,027 Ci of O-15 were released. Tritium produced from activation of the target cooling water was also released, but in a much smaller quantity, 7.32E-02 Ci. Emissions of C-11 and O-15 declined by more than 28 percent from 2003, primarily due to a reduced period of operation (11 weeks in 2004 compared to 16 weeks in 2003).

4.1.4 Evaporator Facility

In the past, liquid wastes generated on site that contained residual radioactivity was accumulated at the Waste Concentration Facility (WCF) in Building 811. At the WCF, reverse osmosis was used to remove suspended solids and a high percentage of radionuclides from the liquid. Because tritium is an isotope of hydrogen, it could not be removed from the aqueous wastes. The tritiated water that remained following waste concentration was transferred to the Evaporator Facility in Building 802B, where it was converted to steam and released as an airborne emission. The Evaporator Facility was constructed primarily to reduce the amount of tritiated water released to the Peconic River through the BNL Sewage Treatment Plant. Emissions from the Evaporator Facility were previously directed to the same stack used by the HFBR to exhaust building air. This method was preferable to releases to surface water because there was virtually no potential for the airborne emissions to influence groundwater (the primary drinking water source on Long Island), and the potential for the released tritium to contribute to an off-site dose was minimized by atmospheric dispersion.

No aqueous waste has been processed at the WCF since 2001. As a result, the Evaporator

Facility has not been used and produced no emissions of tritiated water vapor in 2004. Because generation rates of aqueous wastes containing residual radioactivity are expected to remain low, it was no longer cost effective to process the waste in the same manner. Wastes are now processed through solidification with off-site disposal.

4.1.5 Target Processing Laboratory

As mentioned in Section 4.1.3, the metal targets irradiated at the BLIP are transported to the TPL in Building 801, where isotopes are chemically extracted for radiopharmaceutical production. Airborne radionuclides that are released during the extraction process are drawn through multistage HEPA and charcoal filters and then vented to the HFBR stack. The types of radionuclides that are released depend on the isotopes chemically extracted from the irradiated metal targets, which can change from year to year. Annual radionuclide quantities released from this facility are very small, typically in the μCi to mCi range. In 2004, the total release from the TPL was 0.0016 μCi . See Table 4-1 for details of all radionuclides released in 2004.

4.1.6 Additional Minor Sources

Several research departments at BNL use designated fume hoods for work that involves very small quantities of radioactive materials (in the μCi to mCi range). The work done using fume hoods typically involves transferring material between containers, using pipettes, and labeling chemical compounds. Due to the use of HEPA filters and activated charcoal filters, the nature of the work conducted, and the small quantities involved, these operations have a very low potential for atmospheric releases of any significant quantities of radioactive materials. Compliance with NESHAPs Subpart H is demonstrated through the use of an inventory system that allows an upper estimate of potential releases to be calculated. Facilities that demonstrate compliance in this way include Buildings 463, 490, 490A, 510, 535, 555, 725, and 801, where research is conducted in the fields of biology, medicine, high

Table 4-1. Airborne Radionuclide Releases from Monitored Facilities.

Facility	Nuclide	Half-Life	Ci Released
BMRR	Argon-41	1.8 hours	None
	Tritium	12.3 years	0.0763*
HFBR	Tritium	12.3 years	3.94E+00
BLIP	Carbon-11	20.4 minutes	6.80E+02
	Oxygen-15	122 seconds	2.03E+03
	Tritium	12.3 years	7.32E-02
TPL - Bldg. 801	Cesium-137	30.1 years	2.06E-12
	Cobalt-60	5.3 years	5.97E-11
	Germanium-68	270.8 days	1.87E-08
	Europium-152	13.5 years	9.96E-10
Total			2.71E+03

Notes:

Ci = 3.7×10^{10} Bq

BLIP = Brookhaven Linac Isotope Producer

BMRR = Brookhaven Medical Research Reactor (operations were terminated in December 2000)

HFBR = High Flux Beam Reactor (operations were terminated in November 1999)

TPL = Target Processing Laboratory

* Estimated release (see Section 4.1.1 for details)

energy physics, chemistry, applied and materials science, and advanced technology. See Table 8-4 in Chapter 8 for the calculated dose from these facility emissions.

4.1.7 Nonpoint Radiological Emission Sources

Nonpoint radiological emissions from a variety of diffuse sources were evaluated in 2004 for compliance with NESHAPs Subpart H. Diffuse sources evaluated included planned environmental restoration and waste management activities. The EPA-approved CAP88-PC dose modeling program was used to calculate the dose to members of the public from each of the planned activities. The evaluations determined whether NESHAPs permitting and continuous monitoring requirements were applicable, or whether periodic confirmatory sampling was needed to ensure compliance with Subpart H standards for radionuclide emissions. Chapter 8 discusses the NESHAPs evaluations of the environmental restoration and waste management activities that occurred in 2004.

4.2 FACILITY MONITORING

In the past, potential sources of radioactive particulate emissions that have been monitored included the BMRR, the HFBR, the Evaporator Facility, the TPL, and the BLIP. Since the BMRR and HFBR are permanently shut down and the Evaporator Facility did not process any aqueous wastes in 2004, no particulate sampling was conducted at these facilities.

The samplers in the exhaust duct for the TPL and the exhaust stack for the BLIP are equipped with glass-fiber filters that capture samples of airborne particulate matter generated at these facilities (see Figure 4-3 for locations). The filters are collected and analyzed weekly for gross alpha and beta activity. Particulate filter analytical results for gross alpha and beta activity are reported in Table 4-2. Annual average gross alpha and beta airborne activity levels for samples collected from the TPL were 0.0102 and 0.0611 pCi/m³, respectively. The annual average airborne activity levels for samples collected from the BLIP exhaust stack were 0.0496 pCi/m³ (gross alpha) and 1.0106 pCi/m³ (gross beta).

4.3 AMBIENT AIR MONITORING

As part of the Environmental Monitoring Program, air monitoring stations are in

Table 4-2. Gross Activity in Facility Air Particulate Filters.

Facility Monitor		Gross Alpha	Gross Beta
		pCi/m ³)	
BLIP	N	50	50
	Max.	0.1900 ± 0.1400	1.5600 ± 0.2840
	Avg.	0.0496 ± 0.0201	1.0106 ± 0.0383
	MDL	0.1810*	0.3224*
TPL - Bldg. 801	N	52	52
	Max.	0.3460 ± 0.1660	1.5700 ± 0.2640
	Avg.	0.0102 ± 0.0062	0.0611 ± 0.0098
	MDL	0.0066*	0.0111*

Notes:

See Figure 4-3 for sample station locations.

All values are presented with a 95% confidence interval.

BLIP = Brookhaven Linac Isotope Producer

MDL = Minimum Detection Limit

N = Number of validated samples collected

TPL = Target Processing Laboratory

*Average MDL for all samples taken at this location

Figure 4-3. BNL On-Site Ambient Air Monitoring Stations.

place around the perimeter of the BNL site. Samplers are housed within six blockhouse stations (see Figure 4-3 for locations). The blockhouses are fenced to control access and protect costly sampling equipment. In 2003, the number of pole-mounted, battery-powered silica-gel samplers used for tritium monitoring was reduced from 16 to three. The elimination of redundant samplers was justified on the basis that historical air surveillance data after the shutdown of

the HFBR and the BMRR revealed that, at most of the sampling stations, the tritium concentrations were below the minimum detection limits (MDL). Figure 4-3 in the 2003 Site Environmental Report may be referenced for the locations of portable samplers no longer included in surveillance monitoring.

At each blockhouse, particulate matter is captured on a glass-fiber filter, and water vapor for tritium analysis is collected on silica-gel absorbent material. Particulate filters are col-

lected weekly and are analyzed for gross alpha and beta activity using a gas-flow proportional counter. In 2004, silica-gel samples were collected biweekly.

4.3.1 Gross Alpha and Beta Airborne Activity

Particulate filter analytical results for gross alpha and beta airborne activity are reported in Table 4-3. Validated samples are those not rejected due to equipment malfunction or other factors (e.g., sample air volumes were not acceptable). The annual average gross alpha and beta airborne activity levels for the six monitoring stations were 0.0011 and 0.0136 pCi/m³, respectively. Annual gross beta activity trends recorded at Station P7 are plotted in Figure 4-4. The results for this location are typical for the site. The trend shows seasonal variation in activity within a range that is representative of natural background levels.

The New York State Department of Health (NYSDOH) received duplicate filter samples that were collected at Station P7 using a sampler they provided. These samples were collected weekly and analyzed by the NYSDOH laboratory for gross beta activity only. The analytical results received were comparable to the Station P7 samples analyzed by the BNL Analytical Services Laboratory and Severn-Trent Laboratories, LLC, an off-site contract laboratory. Analytical results for gross beta activity reported by the NYSDOH laboratory were between 0.0077 and 0.0246 pCi/m³, with an average concentration of 0.0148 pCi/m³, whereas the BNL results ranged from 0.0027 to 0.0201 pCi/m³, with an average concentration of 0.0129 pCi/m³. As part of a statewide monitoring program, NYSDOH also collects air samples in Albany, New York, a control location with no potential to be influenced by nuclear facility emissions. In 2004, NYSDOH reported that airborne gross beta activity at that location varied between 0.0013 and 0.019 pCi/m³ and the average concentration was 0.0088 pCi/m³. Sample results measured at BNL generally fell within this range, demonstrating that on-site radiological air quality was consistent with that observed at locations in New York State not located near radiological facilities.

Table 4-3. Gross Activity Detected in Ambient Air Monitoring Particulate Filters.

Sample Station		Gross Alpha	Gross Beta
		(pCi/m ³)	
P2	N	51	51
	Max	0.0020 ± 0.0007	0.0201 ± 0.0017
	Avg.	0.0007 ± 0.0002	0.0105 ± 0.0004
	MDL	0.0006*	0.0009*
P4	N	48	48
	Max	0.0027 ± 0.0010	0.0281 ± 0.0035
	Avg.	0.0012 ± 0.0002	0.0152 ± 0.0005
	MDL	0.0008*	0.0013*
P7	N	45	45
	Max	0.0027 ± 0.0022	0.0201 ± 0.0035
	Avg.	0.0013 ± 0.0002	0.0129 ± 0.0004
	MDL	0.0007*	0.0012*
P9	N	52	52
	Max	0.0021 ± 0.0007	0.0258 ± 0.0031
	Avg.	0.0011 ± 0.0001	0.0151 ± 0.0004
	MDL	0.0008*	0.0013*
S5	N	51	51
	Max	0.0023 ± 0.0007	0.0244 ± 0.0018
	Avg.	0.0010 ± 0.0002	0.0135 ± 0.0004
	MDL	0.0007*	0.0012*
S6	N	52	52
	Max	0.0028 ± 0.0009	0.0233 ± 0.0028
	Avg.	0.0011 ± 0.0002	0.0144 ± 0.0004
	MDL	0.0008*	0.0013*
Grand Average		0.0011 ± 0.0001	0.0136 ± 0.0005

Notes:

See Figure 4-3 for sample station locations.

All values are presented with a 95% confidence interval.

MDL = Minimum Detection Limit

N = Number of validated samples collected

*Average MDL for all samples taken at this location

4.3.2 Airborne Tritium

Airborne tritium in the form of tritiated water vapor (HTO) is monitored throughout the BNL site. In addition to the five blockhouses containing tritium samplers, three pole-mounted monitors used for tritium sampling are located at or near the property boundary (see Figure 4-3 for locations). Airborne tritium is collected by using a pump to draw air through a column of silica gel, a water-absorbent medium.

Figure 4-4. Airborne Gross Beta Concentration Trend Recorded at Station P7.

The absorbed HTO is recovered by distillation and analyzed using liquid scintillation counting techniques.

Table 4-4 lists the number of validated samples collected at each location, the maximum value observed, and the annual average concentration. Validated samples are those not rejected due to equipment malfunction or other factors (e.g., a battery failure in the sampler, frozen or supersaturated silica gel, or the loss of sample during laboratory preparation). Airborne tritium samples were collected biweekly from each sampling station during 2004. The average tritium concentrations at all of the sampling locations were less than the typical MDL, which ranged from 1.0 to 7.0 pCi/m³. The collected data demonstrate that there were no significant differences in ambient tritium concentrations on site or at the site boundary. Observed concentrations of tritium at the sampling stations in 2004 were comparable to concentrations observed in 2003.

4.4 NONRADIOLOGICAL AIRBORNE 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. BNL has several other emission sources subject to state and federal regulatory requirements that do not require emission monitoring (see Chapter 3 for more details). The CSF

Table 4-4. Ambient Airborne Tritium Measurements.

Sample Station	Wind Sector	Validated Samples	Maximum _____ (pCi/m ³) _____	Average
049	E	24	1.7 ± 1.2	0.3 ± 0.4
053	NW	24	2.0 ± 1.9	0.8 ± 0.3
122	SSE	24	2.7 ± 4.5	0.4 ± 0.3
P2	NNW	24	2.6 ± 0.6	0.7 ± 0.4
P4	WSW	25	2.6 ± 0.6	0.7 ± 0.4
P7	ESE	25	1.5 ± 1.3	0.3 ± 0.2
P9	NE	25	2.0 ± 0.6	0.4 ± 0.3
S6	SE	25	4.5 ± 3.2	0.6 ± 0.5
Grand Average				0.4 ± 0.1
DOE Order 5400.5 Air Derived Concentration Guide				100,000 pCi/m³

Notes:

See Figure 4-3 for sample station locations.

Wind sector is the downwind direction of the sample station from the HFBR stack.

All values are presented with a 95% confidence interval.

Typical minimum detection limit for tritium is between 1.0 and 7.0 pCi/m³.

supplies steam for heating and cooling to major facilities at BNL through an underground steam distribution and condensate grid. The location of the CSF is shown in Figure 4-1. The combustion units at the CSF are designated as Boilers 1A, 5, 6, and 7. Boiler 1A, which was installed in 1962, has a heat input of 16.4 MW (56.7 MMBtu/hr). Boiler 5, installed in 1965, has a heat input of 65.3 MW (225 MMBtu/hr). The newest units, Boilers 6 and 7, were installed in 1984 and 1996, respectively. Each of these boilers has a heat input of 42.6 MW (147 MMBtu/hr). For perspective, Keyspan's Northport, New York power station has three utility-sized turbine/generator boilers, each with a maximum rated heat input of 385 MW (3,435 MMBtu/hr) and one with a maximum rated heat input of 990 MW (3,381 MMBtu/hr).

Because of their design, heat inputs, and dates of installation, Boilers 6 and 7 are subject to Title 6 of the New York Code, Rules, and Regulations (NYCRR) Part 227-2, and the Federal New Source Performance Standard (40 CFR 60 Subpart Db: *Standards of Performance for Industrial-Commercial-Institutional Steam Boilers*). Therefore, these boilers are equipped with continuous emission monitors to measure nitrogen oxides (NO_x). Boiler 7 was already

equipped with a continuous opacity monitor to comply with Subpart Db opacity monitoring requirements, and after a new continuous opacity monitor for Boiler 6 was voluntarily brought on-line in 2004, emissions on both boilers are now continuously monitored for opacity. To measure combustion efficiency, both boilers are also monitored for carbon dioxide (CO₂). Continuous emission monitoring results from the two boilers are reported quarterly to EPA and the New York State Department of Environmental Conservation (NYSDEC).

From May 1 to September 15 (the peak ozone period), compliance with the 0.30 lbs/MMBtu (129 ng/J) NO_x emission standard for No. 6 oil and the 0.20 lbs/MMBtu (86ng/J) NO_x emission standard for No. 2 oil and natural gas is demonstrated by calculating the 24-hour average emission rate from continuous emission monitoring system readings and comparing the value to the emission standard. The remainder of the year, the calculated 30-day rolling average emission rate is used to establish compliance. Boiler 6 and 7 opacity levels are recorded as 6-minute averages. Measured opacity levels cannot exceed 20 percent opacity, except for one 6-minute period per hour of not more than 27 percent opacity. In 2004, there were no mea-

Table 4-5. Central Steam Facility Fuel Use and Emissions (1996 – 2004).

Year	Annual Fuel Use and Fuel Heating Values						Emissions			
	No. 6 Oil (10 ³ gals)	Heating Value (MMBtu)	No. 2 Oil (10 ³ gals)	Heating Value (MMBtu)	Natural Gas (10 ⁶ ft ³)	Heating Value (MMBtu)	TSP (tons)	NO _x (tons)	SO ₂ (tons)	VOCs (tons)
1996	4,782.55	703,991	52.77	7,388	0.00	0	14.0	104.9	109.0	0.7
1997	3,303.43	484,613	10.23	1,432	190.65	194,463	13.7	83.5	75.1	1.0
1998	354.28	52,283	9.44	1,322	596.17	608,093	2.7	75.1	8.9	1.7
1999	682.76	78,335	2.77	388	614.98	627,280	5.1	53.5	16.7	1.8
2000	2,097.32	309,317	0.82	115	342.40	349,248	9.5	81.6	45.0	1.2
2001	3,645.10	538,847	3.40	476	103.96	106,039	17.5	80.4	77.8	0.8
2002	2,785.04	407,518	0.29	41	220.62	225,030	15.4	62.4	53.8	1.0
2003	4,290.95	628,765	402.06	56,288	0.98	1,000	22.8	75.3	107.1	0.6
2004	4,288.76	628,063	2.45	343	0.11	109	16.4	81.9	104.7	2.4

Notes:

NO_x = Oxides of Nitrogen

SO₂ = Sulfur Dioxide

TSP = Total Suspended Particulates

VOCs = Volatile Organic Compounds

sured exceedances of the NO_x emission standards for either boiler. During the year, all but two of the Boiler 6 opacity measurements and all of the Boiler 7 opacity measurements that exceeded the limit occurred during boiler start-ups or routine boiler tube soot blowing operations. These exceedances were reported to NYSDEC. While there are no regulatory requirements to continuously monitor opacity for Boilers 1A, and 5, surveillance monitoring of visible stack emissions is a condition of BNL's Title V operating permit. Daily observations of stack gases recorded by CSF personnel throughout the year showed no visible emissions with opacity levels exceeding the regulatory limits established for these boilers.

In the spring of 1997, the Long Island Lighting Company completed work extending a natural gas main into the CSF. To accommodate the combustion of natural gas, new gas rings were added to the burners of Boiler 5, and natural gas trains were installed to connect the gas main to Boilers 5 and 7. In 1998, existing steam-atomized oil burners on Boiler 6 were replaced with two dual-fuel low-NO_x burners, and a natural gas train was added to connect the boiler to the gas main.

Throughout 2004, natural gas prices exceeded those for residual fuel oil. As a result, residual fuel supplied more than 99.9 percent of the heating and cooling needs of BNL's major facilities while the combustion of natural gas

accounted for less than one tenth of 1 percent of these heating and cooling needs. By comparison, in 1999 natural gas satisfied more than 88 percent of the major facility heating and cooling needs, and in 2002, 36 percent. Consequently, 2004 emissions of particulates, NO_x, and SO₂ were 11.3, 27.4, and 98.0 tons higher than the respective totals for 1999 and were 1.0, 19.5, and 50.9 tons higher than the respective emission totals for 2002. Table 4-5 shows fuel use and emissions since 1996.

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Water Quality

Brookhaven National Laboratory (BNL) discharges wastewater to surface waters via the Sewage Treatment Plant (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 help ensure that wastewater discharges comply with all applicable requirements and that the public, employees, and environment are protected.

Analytical data for 2004 show that 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 to the Peconic River returned to below 2002 levels and are expected to decline as the rate of off-gassing from the High Flux Beam Reactor slows. The maximum concentration of tritium released was approximately 2 percent of the drinking water standard. Analysis of the STP discharge continues to show no detection of cesium-137 or strontium-90 in the effluent; no other gamma-emitting radionuclides attributable to BNL operations were detected. While very low concentrations of tritium were occasionally detected at the STP outfall, there were no detections of tritium, or any other radionuclide attributable to BNL operations, above the minimum detection limit at any downstream monitoring station. Monitoring immediately downstream of the STP discharge was limited, due to interrupted downstream flow to permit excavation of river-bed sediments as part of the Peconic River Remediation project.

Nonradiological monitoring of the effluent showed that, with the exception of isolated incidents of noncompliance, organic and inorganic parameters were within State Pollutant Discharge Elimination System effluent limitations or other applicable standards. Inorganic data from the upstream, downstream, and control locations demonstrated that elevated amounts of aluminum and iron detected in the Peconic River were a result of natural sources. In addition, the low pH of water samples collected at several sections of the river was also due to natural causes.

5.1 SURFACE WATER MONITORING PROGRAM

Treated wastewater from the STP is discharged into the headwaters of the Peconic River. This discharge is permitted under the New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) Program. Effluent limits are based on the water quality standards

established by NYSDEC, as well as historical operational data. To assess the impact of this discharge on the quality of the river, surface water monitoring is conducted at several locations upstream and downstream of the discharge point. Monitoring Station HY (see Figure 5-8), located on site but upstream of all BNL operations, provides information on the “background” water quality of the Peconic River. The Carmans River

Figure 5-1. Schematic of BNL's Sewage Treatment Plant (STP).

is monitored as a geographic control location for comparative purposes, as it is not affected by BNL operations.

On the BNL site, the Peconic River is an intermittent stream. Off-site flow only occurs during periods of sustained precipitation, typically in the spring. Off-site flow was recorded from January through May, at which time the Peconic River remediation project started. The project diverted flow from immediately downstream of the STP discharge to just downstream of station HQ at the site boundary; consequently, there was no flow recorded at station HM-N or station HQ from June through November. Collection of samples resumed in December. The following sections describe BNL's surface water monitoring and surveillance program.

5.2 SANITARY SYSTEM EFFLUENT

The STP effluent (Outfall 001) is a discharge point operated under a SPDES permit issued by NYSDEC. Figure 5-1 shows a schematic of the STP and its sampling locations. The BNL STP

treatment process includes five steps: 1) primary clarification to remove settleable solids and floatable materials, 2) aerobic oxidation for secondary removal of biological matter and nitrification of ammonia, 3) secondary clarification, 4) sand filtration for final solids removal, and 5) ultraviolet disinfection for bacterial control prior to discharge to the Peconic River. Tertiary treatment for nitrogen removal also is provided by controlling the oxygen levels in the aeration tanks. During the aeration process (i.e., Step 2), the oxygen levels are allowed to drop to the point where microorganisms use nitrate-bound oxygen for respiration; this liberates nitrogen gas and consequently reduces the concentration of nitrogen in the STP discharge.

Nitrogen is an essential nutrient in biological systems that, in high concentrations, can cause excessive aquatic vegetation growth. During the night (when photosynthesis does not occur), aquatic plants use oxygen in the water. Too much oxygen uptake by aquatic vegetation deprives a water system of oxygen needed by

fish and other aquatic organisms for survival. Limiting the concentration of nitrogen in the STP discharge helps keep plant growth in the Peconic River in balance with the nutrients provided by natural sources.

Real-time monitoring of the sanitary waste stream for radioactivity, pH, and conductivity takes place at two locations. The first site (MH-192, see Figure 5-1) is approximately 1.1 miles upstream of the STP, providing at least 30 minutes' warning to the STP operators if wastewater is enroute that may exceed SPDES limits or BNL effluent release criteria (which are more stringent than DOE-specified levels). The second site is at the point where the STP influent enters the primary clarifier, as shown in Figure 5-1. In addition to the monitoring that occurs at these two stations, as effluent leaves the primary clarifier it is also monitored for radioactivity.

Based on the data collected by the real-time monitoring systems, any influent to the clarifier that may not meet SPDES limits or BNL effluent release criteria is diverted to two double-lined holding ponds. The total combined capacity of the two holding ponds exceeds 7 million gallons, or approximately 21 days of flow. Diversion continues until the water quality of the effluent meets the permit limits or release criteria. If wastewater is diverted to the holding ponds, it is tested and evaluated against the requirements for release. If necessary, the wastewater is treated, then reintroduced into the STP at a rate that ensures compliance with SPDES permit limits (for nonradiological parameters) or BNL effluent release criteria (for radiological parameters). In 2004, the STP influent was diverted on one occasion due to the presence of fuel oil in the influent stream. Investigation revealed that a heat exchanger at the Central Steam Facility (CSF) had a leaking tube bundle, and a small volume of oil (< 2 gallons) was discharged to the STP. Approximately 400,000 gallons of water were diverted and treated to remove oil sheen before being reintroduced into the STP.

Solids separated in the clarifiers are pumped to an aerobic digester for solids reduction. Sludge is periodically emptied into solar/heat lamp-powered drying beds, where it is dried to a

semisolid cake. The dried sludge contains very low levels (less than 2.0 pCi/g) of radioactivity, such as residual levels of cobalt-60 (Co-60) from historic sewage releases. The dried sludge is put into containers for off-site disposal at an authorized facility.

5.2.1 Sanitary System Effluent – Radiological Analyses

Wastewater at the STP is sampled at the output of the primary clarifier (Station DA) and at the Peconic River Outfall (Station EA). At each location, samples are collected on a flow-proportional basis; for every 1,000 gallons of water treated, approximately 4 fluid ounces of sample are collected and composited into a 5-gallon collection container. These samples are analyzed for gross alpha and gross beta activity, and tritium concentrations. During 2004, samples were collected three times weekly. Samples collected from these locations are also composited and analyzed monthly for gamma-emitting radionuclides and strontium-90 (Sr-90).

Although the Peconic River is not used as a direct source of potable water, BNL applies the stringent Safe Drinking Water Act (SDWA) standards for comparison purposes when monitoring the effluent, in lieu of DOE wastewater criteria. EPA revised the SDWA limits for radionuclides in 2003. Under these revisions, the gross activity limit for beta emitters (50 pCi/L) was replaced with a 4 mrem (40 μ Sv) dose limit. The SDWA specifies that no individual may receive an annual dose greater than 4 mrem (40 μ Sv) from radionuclides that are beta or photon emitters. Beta/photon emitters include up to 168 individual radioisotopes. BNL performs radionuclide-specific gamma analysis to ensure compliance with this standard. The SDWA annual average gross alpha activity limit is 15 pCi/L, including radium-226 (Ra-226) but excluding radon and uranium. Other SDWA-specified drinking water limits are 20,000 pCi/L for tritium, 8 pCi/L for Sr-90, 5 pCi/L for Ra-226 and radium-228 (Ra-228), and 30 μ g/L for uranium. Gross activity (alpha and beta) measurements are used as a screening tool for detecting the presence of radioactivity. Table 5-1 shows the monthly gross alpha and beta activity data and

tritium concentrations for the STP influent and effluent during 2004. Annual average gross alpha and beta activity levels in the STP effluent were 0.7 ± 0.3 pCi/L and 4.6 ± 0.3 pCi/L, respectively. Control location data (Carmans River Station HH; see Figure 5-8) show aver-

age gross alpha and beta levels of 0.17 ± 0.39 pCi/L and 2.08 ± 1.18 pCi/L, respectively (see Table 5-7).

Tritium detected at the STP originates from either High Flux Beam Reactor (HFBR) sanitary system releases, or from small, infrequent

Table 5-1. Tritium and Gross Activity in Water at the BNL Sewage Treatment Plant (STP).

	Monthly Flow	Tritium Maximum	Tritium Average	Gross Alpha Maximum	Gross Alpha Average	Gross Beta Maximum	Gross Beta Average
	(Liters)	(pCi/L)					
STP Influent							
January	2.99E+07	< 344	22 ± 48	6.2 ± 2.4	3.8 ± 0.9	13.1 ± 4.7	6.5 ± 1.8
February	3.56E+07	260 ± 230	107 ± 61	< 2.1	0.4 ± 0.3	6.9 ± 1.6	5.4 ± 0.5
March	3.28E+07	360 ± 210	100 ± 80	< 1.8	0.4 ± 0.3	6.7 ± 1.2	5.4 ± 0.4
April	4.28E+07	560 ± 250	134 ± 98	< 1.9	0.5 ± 0.4	6.3 ± 1.5	5.1 ± 0.5
May	4.36E+07	300 ± 160	88 ± 58	2.3 ± 2.6	0.4 ± 0.4	15.0 ± 10.0	6.3 ± 1.9
June	4.41E+07	< 240	105 ± 40	< 1.7	0.2 ± 0.2	6.1 ± 1.3	4.4 ± 0.6
July	4.88E+07	570 ± 230	160 ± 91	1.4 ± 0.9	0.3 ± 0.2	4.8 ± 1.5	3.1 ± 0.5
August	4.72E+07	700 ± 240	253 ± 103	< 13.0	-0.2 ± 2.9	32.0 ± 13.0	7.7 ± 5.5
September	3.81E+07	< 280	85 ± 54	< 1.5	0.4 ± 0.2	6.3 ± 1.5	3.0 ± 1.1
October	3.07E+07	< 350	-11 ± 57	< 3.3	0.3 ± 0.3	7.0 ± 1.8	5.0 ± 0.8
November	3.26E+07	< 230	45 ± 43	< 1.8	0.4 ± 0.2	7.4 ± 1.4	5.1 ± 1.0
December	3.32E+07	< 300	-29 ± 66	< 2.8	0.7 ± 0.3	6.7 ± 1.5	5.7 ± 0.4
Annual Average			88 ± 23		0.6 ± 0.3		5.2 ± 0.6
STP Effluent							
January	4.27E+07	320 ± 195	99 ± 83	7.0 ± 2.5	5.3 ± 0.9	11.0 ± 4.2	7.2 ± 1.6
February	4.86E+07	290 ± 170	79 ± 48	4.3 ± 2.4	0.7 ± 0.7	6.6 ± 1.6	5.0 ± 0.4
March	4.42E+07	< 350	127 ± 43	< 2.5	0.5 ± 0.4	6.4 ± 1.2	5.0 ± 0.8
April	5.76E+07	< 310	54 ± 74	< 1.4	0.4 ± 0.2	6.1 ± 1.4	4.5 ± 0.6
May	5.20E+07	230 ± 150	102 ± 55	< 1.3	0.3 ± 0.3	11.2 ± 3.4	6.2 ± 1.4
June	5.53E+07	380 ± 280	67 ± 90	< 1.1	0.4 ± 0.2	6.1 ± 1.4	4.4 ± 0.5
July	4.66E+07	460 ± 220	160 ± 76	< 1.4	0.3 ± 0.2	4.5 ± 1.4	3.2 ± 0.5
August	4.20E+07	450 ± 200	229 ± 79	1.2 ± 0.8	0.2 ± 0.2	8.0 ± 1.7	3.5 ± 1.0
September	3.67E+07	260 ± 160	93 ± 55	< 1.4	0.2 ± 0.2	4.4 ± 1.2	2.8 ± 0.8
October	2.95E+07	< 240	20 ± 44	< 1.9	0.1 ± 0.3	6.2 ± 1.5	4.5 ± 0.7
November	3.13E+07	< 270	18 ± 44	< 2.0	0.2 ± 0.3	7.7 ± 1.4	4.5 ± 0.9
December	3.24E+07	< 330	1 ± 74	< 1.7	0.0 ± 0.2	6.7 ± 1.4	4.9 ± 0.5
Annual Average			86 ± 21		0.7 ± 0.3		4.6 ± 0.3
Total Release	5.19E+08		54.3 mCi		0.036 mCi		2.4 mCi
Average MDL (pCi/L)			312		2.1		5.8
SDWA Limit (pCi/L)			20,000		15		(a)

Notes:

All values are reported with a 95% confidence interval.
 Negative numbers occur when the measured value is lower than background (See Appendix B for description).
 To convert values from pCi to Bq, divide by 27.03.
 MDL = Minimum Detection Limit
 SDWA = Safe Drinking Water Act

(a) The drinking water standards were changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in late 2003. Because gross beta activity does not identify specific radionuclides, a dose equivalent cannot be calculated for the values in the table.

Figure 5-2. Tritium Concentrations in Effluent from the BNL Sewage Treatment Plant (2004).

batch releases from other facilities that meet BNL discharge criteria. Although the HFBR is no longer operating, tritium continues to be released from the facility at very low concentrations, due to off-gassing. During its operation, the air within the reactor building contained high levels of tritium in the form of water vapor. The water was absorbed by many porous surfaces and materials, which slowly liberate the tritiated moisture as it is replaced by untritiated water. Once tritium is in the air stream, it condenses as a component of water vapor in the

air conditioning or air compressor units and is discharged as sanitary wastewater. To minimize the quantity of tritium released to the STP, efforts have been made to capture most of the air conditioning condensate collected on the equipment level of the HFBR. A plot of the 2004 tritium concentrations recorded in the STP effluent is presented in Figure 5-2. A 15-year trend plot of annual average tritium concentrations measured in the STP discharge is shown in Figure 5-3. The annual average concentration trend has been declining since 1995.

Figure 5-3. Sewage Treatment Plant/Peconic River Annual Average Tritium Concentrations (1990–2004).

In 2004, a total of 0.054 Ci of tritium was released during the year (see Figure 5-4). The annual average tritium concentration as measured in the STP effluent (EA, Outfall 001) was 86 ± 21 pCi/L, which is approximately half that recorded for 2003 and well below the drinking water standard (DWS) of 20,000 pCi/L. The 2004 value is approximately one-quarter the average minimum detection limit (MDL) of 293 pCi/L. The maximum concentration detected in the STP discharge (see Table 5-1) was 460 ± 220 pCi/L, approximately 65 percent of the maximum level in 2003 of 704 pCi/L. Tritium was detected above the MDL in samples collected from June through August (when discharges increase due to HFBR air conditioning condensate). These levels should continue to decrease, provided no additional work is conducted that could expose tritium contained in reactor components.

Table 5-2 presents the gamma spectroscopy analytical data for anthropogenic radionuclides historically detected in the monthly STP wastewater composite samples. During 2004, there were no gamma-emitting nuclides detected in the STP effluent, which is consistent with the data reported for 2003. In 2002/2003, under the BNL Environmental Restoration Program, 1,320 yd³ of sand and debris containing low levels of radioactivity and heavy metals were removed from the STP sand filters; the source of continual low-level releases of cesium-137

(Cs-137) and Sr-90. With the source removed, all future discharges from the STP are assured to be free of these contaminants (see Figure 5-5).

5.2.2 Sanitary System Effluent – Nonradiological Analyses

In addition to the compliance monitoring discussed in Chapter 3, effluent from the STP is also monitored for nonradiological contaminants under the environmental surveillance program. Data are collected for field-measured parameters such as temperature, specific conductivity, pH, and dissolved oxygen, as well as inorganic parameters such as chlorides, nitrates, sulfates, and metals. Composite samples of the STP effluent are collected using a flow-proportional refrigerated sampling device (ISCO Model 3700RF) and are then analyzed by contract laboratories. Samples are analyzed for 21 inorganic elements, anions, semivolatile organic compounds (SVOCs), pesticides, and herbicides. In addition, grab samples are collected monthly from the STP effluent and analyzed for 38 different volatile organic compounds (VOCs). Daily influent and effluent logs are maintained by the STP operators for flow, pH, temperature, and settleable solids as part of routine monitoring of STP operations.

Table 5-3 summarizes the water quality and inorganic analytical results for the STP samples. Comparing the effluent data to the SPDES ef-

Figure 5-4. Tritium Released to the Peconic River, 15-Year Trend (1990–2004).

Table 5-2. Gamma-Emitting Radionuclides and Strontium-90 in Water at the BNL Sewage Treatment Plant (STP).

	Flow (Liters)	Co-60	Cs-137	Be-7	Na-22	Sr-90
		(pCi/L)				
STP Influent						
January	2.99E+07	ND	ND	ND	ND	ND
February	3.56E+07	ND	ND	ND	ND	ND
March	3.28E+07	ND	ND	ND	ND	ND
April	4.28E+07	ND	ND	ND	ND	ND
May	4.36E+07	ND	ND	ND	ND	ND
June	4.41E+07	ND	ND	ND	ND	ND
July	4.88E+07	ND	ND	ND	ND	ND
August	4.72E+07	ND	ND	ND	ND	ND
September	3.81E+07	ND	ND	ND	ND	ND
October	3.07E+07	ND	ND	ND	ND	ND
November	3.26E+07	ND	ND	ND	ND	ND
December	3.32E+07	ND	ND	ND	ND	ND
STP Effluent						
January	4.27E+07	ND	ND	ND	ND	ND
February	4.86E+07	ND	ND	ND	ND	ND
March	4.42E+07	ND	ND	ND	ND	ND
April	5.76E+07	ND	ND	ND	ND	ND
May	5.20E+07	ND	ND	ND	ND	ND
June	5.53E+07	ND	ND	ND	ND	ND
July	4.66E+07	ND	ND	ND	ND	ND
August	4.20E+07	ND	ND	ND	ND	ND
September	3.67E+07	ND	ND	ND	ND	ND
October	2.95E+07	ND	ND	ND	ND	ND
November	3.13E+07	ND	ND	ND	ND	ND
December	3.24E+07	ND	ND	ND	ND	ND
Total Release to the Peconic River (mCi)		0	0	0	0	0
DOE Order 5400.5 DCG (pCi/L)		5,000	3,000	50,000	10,000	1,000
Dose limit of 4 mrem EDE (pCi/L)		100	200	6,000	400	8

Notes:

No BNL-derived radionuclides were detected in the effluent to the Peconic River for 2004.

To convert values from pCi to Bq, divide by 27.03.

DCG = Derived Concentration Guide

EDE = Effective Dose Equivalent

ND = Not Detected

Figure 5-5. Cesium-137 in the BNL Sewage Treatment Plant Influent and Effluent (1990–2004).

fluent limits (or New York State Ambient Water Quality Standards [NYS AWQS], as appropriate) shows that most of the analytical parameters were within SPDES effluent permit limits (see also the compliance data in Chapter 3). During 2004, a single sample collected in October exhibited a nitrate concentration of 11 mg/L, exceeding the SPDES discharge limit of 10 mg/L. All other samples were well below the limit, with an average concentration of 6 mg/L for the year. Potential causes of the elevated nitrogen value include an outdoor source (e.g., animal), decaying organic matter in the flow channel, or too high an oxygen level through the treatment process.

There were three instances when aluminum exceeded the NYS AWQS, and one instance when iron was detected at a concentration exceeding the SPDES limits. Both aluminum and iron are components of native soil and are most likely attributable to fine particles of sand carried over in the effluent. In July 2004, an evaluation was performed to determine the cause of an iron excursion reported under the compliance sampling program (see Chapter 3). Placement of the sample collection probe along the bottom of the flow channel resulted in collection of sediment in the sample and consequently higher levels of iron and aluminum. Comparing the aluminum and iron concentrations in the effluent to the levels in samples from Peconic River upstream and off-site locations shows that the STP effluent levels are lower than in comparable streams. See Section 5.5 for further discussion of the Peconic River and other surface waters.

Except for a single detection (19 µg/L) of acetone, a common laboratory contaminant, no organic compounds were detected above the MDL in 2004. Although there are no SPDES limits or ambient water quality standards specified for acetone, NYSDEC imposes a generic limit of 50 µg/L for unlisted organic compounds.

5.3 PROCESS-SPECIFIC WASTEWATER

Wastewater that may contain constituents above SPDES permit limits or NYS AWQS standards must be held by the generating facility and characterized to determine the appropriate means of disposal. The analytical results are compared

with the appropriate discharge limit, and the wastewater is released to the sanitary system only if the volume and concentration of contaminants in the discharge would not jeopardize the quality of the STP effluent and subsequently the Peconic River.

The BNL SPDES permit includes requirements for quarterly sampling and analysis of process-specific wastewater discharged from photographic developing operations in Building 197B, printed-circuit-board fabrication operations conducted in Building 535B, metal cleaning operations in Building 498, cooling tower discharges from Building 902, and boiler blow-down from satellite boilers in Buildings 244 and 423. These operations are monitored for contaminants such as metals, cyanide, VOCs, and SVOCs. Analyses of these waste streams in 2004 showed that, although several operations contributed contaminants to the STP in concentrations exceeding SPDES-permitted levels, these discharges did not affect the quality of the STP effluent. By the end of 2004, all wet photo-developing operations in Building 197B had been replaced with digital imaging systems and there are no longer any discharges from this facility that require monitoring.

Process wastewaters that were not expected to be of consistent quality because they were not routinely generated were held for characterization before release to the site sewer system. The process wastewaters typically included primary closed-loop cooling water, heat exchanger cleaning wastewater, wastewater generated as a result of restoration activities, and other industrial wastewaters. To determine the appropriate disposal method, samples were analyzed for contaminants specific to the process. The analyses were then reviewed and the concentrations were compared to the SPDES effluent limits and BNL effluent release criteria. If the concentrations were within limits, authorization for sewer system discharge was granted; if not, alternate means of disposal were pursued. Any waste that contained elevated levels of hazardous or radiological contaminants in concentrations that exceeded BNL effluent release criteria was sent to the BNL Waste Management Facility for proper disposal.

Table 5-3. BNL Sewage Treatment Plant (STP) Water Quality and Metals Analytical Results.

	STP Influent				STP Effluent				SPDES Limit or AWQS(1)
	No. of Samples	Min.	Max.	Avg.	No. of Samples	Min.	Max.	Avg.	
pH (SU)	CM	5.6	11.9	NA	CM	5.9	7.7	NA	5.8 - 9.0
Conductivity (µS/cm)	CM	NR	NR	NR	162(2)	198	508	316	SNS
Temperature (°C)	CM	10	26	NA	162(2)	1.7	25.4	14.8	SNS
Dissolved Oxygen (mg/L)	NM	NM	NM	NM	162(2)	7.2	15.1	9.8	SNS
Chlorides (mg/L)	12	34.7	57.8	47.0	12	35.7	97.9	53.5	SNS
Nitrate (as N) (mg/L)	6	0.2	3.6	2.2	6	2.8	11.0	6.2	10 (Total N)
Sulfates (mg/L)	12	12.3	20.7	16.7	12	11.5	23.3	17.3	250 (GA)
Aluminum (µg/L)	12	79.5	425.0	194.8	12	23.6	136.0	50.2	100 (Ionic)
Antimony (µg/L)	12	1.3	< 5.0	< 5.0	12	1.5	< 5.0	< 5.0	3 (GA)
Arsenic (µg/L)	12	0.7	< 5.0	< 5.0	12	0.33	< 5.0	< 5.0	150 (Dissolved)
Barium (µg/L)	12	23.5	66.1	42.1	12	8.4	23.9	19.9	1000 (GA)
Beryllium (µg/L)	12	0.5	< 2.0	< 2.0	12	0.6	< 2.0	< 2.0	11 (Acid Soluble)
Cadmium (µg/L)	12	0.2	< 2.0	< 2.0	12	0.2	< 2.0	< 2.0	1.1 (Dissolved)
Calcium (µg/L)	12	9.2	12.4	10.7	12	8.4	13.3	11.0	SNS
Chromium (µg/L)	12	2.2	7.8	4.3	12	1.6	9.1	< 5.0	34.4 (Dissolved)
Cobalt (µg/L)	12	0.4	< 5.0	< 5.0	12	0.2	< 5.0	< 5.0	5 (Acid Soluble)
Copper (µg/L)	12	62.0	188.0	113.7	12	28.4	68.2	41.0	150 (SPDES)
Iron (mg/L)	12	0.7	2.8	1.6	12	0.1	0.4	0.2	0.37 (SPDES)
Mercury (µg/L)	12	0.18	0.69	0.43	12	0.08	0.23	< 0.20	0.8 (SPDES)
Manganese (µg/L)	12	14.1	79.4	38.9	12	2.1	12.8	4.2	300 (GA)
Magnesium (mg/L)	12	3.0	4.6	3.7	8	2.3	4.8	3.6	SNS
Nickel (µg/L)	12	2.4	54.0	12.0	12	3.2	15.8	5.9	110 (SPDES)
Lead (µg/L)	12	4.8	27.0	13.7	12	0.8	4.3	< 3.0	19 (SPDES)
Potassium (mg/L)	12	2.7	9.1	6.1	12	2.4	7.1	5.1	SNS
Selenium (µg/L)	12	1.4	< 5	< 5	12	0.79	< 5	< 5	4.6 (Dissolved)
Silver (µg/L)	12	0.6	2.7	1.5	12	0.6	3.3	1.8	15 (SPDES)
Sodium (mg/L)	12	26.2	64.0	39.6	12	27.4	66.3	40.4	SNS
Thallium (µg/L)	12	0.8	< 5.0	< 5.0	12	0.6	< 5.0	< 5.0	8 (Acid Soluble)
Vanadium (µg/L)	12	2.1	35.6	6.2	12	1.6	7.9	3.5	14 (Acid Soluble)
Zinc (µg/L)	12	38.9	220.0	91.4	12	22.2	88.8	44.4	100 (SPDES)

Notes:

See Figure 5-1 for locations of the STP influent and effluent monitoring locations.

All analytical results were generated using total recoverable analytical techniques.

For Class C AWQS, the solubility state for the metal is provided.

AWQS = Ambient Water Quality Standards

CM = Continuously monitored

GA = Class GA (groundwater) Ambient Water Quality Standard

NA = Not Applicable

NM = Not Monitored

NR = Not Recorded

SNS = Standard Not Specified

SPDES = State Pollutant Discharge Elimination System

SU = Standard Units

(1) Unless otherwise provided, the reference standard is NYSDEC Class C Surface Water Ambient Water Quality Standards.

(2) The conductivity, temperature, and dissolved oxygen values reported are based on analyses of daily grab samples.

Figure 5-6. BNL Outfall Locations.

5.4 RECHARGE BASINS

Recharge basins are used for the discharge of “clean” wastewater streams, including once-through cooling water, stormwater runoff, and cooling tower blowdown. With the exception of elevated temperature and increased natural sediment content, these wastewaters are suitable for direct replenishment of the groundwater aquifer. Figure 5-6 shows the locations of BNL’s discharges to recharge basins (also called “outfalls” under BNL’s SPDES permit). Figure 5-7 presents an overall schematic of potable water use at BNL. Ten recharge basins are used for

managing once-through cooling water, cooling tower blowdown, and stormwater runoff:

- Basins HN, HT-W, and HT-E receive once-through cooling water discharges generated at the Alternating Gradient Synchrotron (AGS) and Relativistic Heavy Ion Collider (RHIC), as well as cooling tower blowdown and stormwater runoff.
- Basin HS receives predominantly stormwater runoff, once-through cooling water from Building 555 (Chemistry Department), and minimal cooling tower blowdown from the National Synchrotron Light Source (NSLS).

Figure 5-7. Schematic of Potable Water Use and Flow at BNL.

- Basin HX receives Water Treatment Plant filter backwash water.
- Basin HO receives cooling water discharges from the AGS and stormwater runoff from the area surrounding the HFBR.
- Several other recharge areas are used exclusively for discharging stormwater runoff. These areas include Basin HW in the warehouse area, Basin CSF at the Central Steam Facility, Basin HW-M at the former Hazardous Waste Management Facility (HWMF), and Basin HZ near Building 902. In late 2004, the basin identified as HW-M was removed as the facility entered into remediation. The former HWMF will be excavated to remove contaminants deposited by past operations and the area will be restored to a natural state.

Each of the recharge basins is a permitted point-source discharge under BNL's SPDES permit. Where required by the permit, the discharge to the basin is equipped with a flow monitoring station; weekly recordings of flow are collected, along with measurements of pH. The specifics of the SPDES Compliance Monitoring Program

are provided in Chapter 3. To supplement that monitoring program, samples are also routinely collected and analyzed under the environmental monitoring program for radioactivity, VOCs, metals, and anions. During 2004, water samples were collected from all the basins listed above except basin HX (at the Water Treatment Plant), which was exempted by NYSDEC from sampling due to documented nonimpact to groundwater, and basin HW-M, which is being monitored as part of the remediation of the former HWMF.

5.4.1 Recharge Basins - Radiological Analyses

Discharges to the recharge basins were sampled throughout the year for subsequent analyses for gross alpha and beta activity, gamma-emitting radionuclides, and tritium. These results are presented in Table 5-4. These data show that low levels of alpha and beta activity were detected in most of the basins. Activities ranged from nondetectable to 2.60 ± 1.30 pCi/L for gross alpha activity, and from nondetectable to 9.90 ± 1.30 pCi/L for gross beta activity. Low-level detections of gross alpha and

Table 5-4. Radiological Analysis of Samples from On-Site Recharge Basins at BNL.

Basin		Gross Alpha	Gross Beta	Tritium
		(pCi/L)		
HN	N	4	4	4
	Max.	2.60 ± 1.30	7.90 ± 1.60	200 ± 120
	Avg.	1.02 ± 1.06	4.24 ± 3.03	68 ± 88
HO	N	4	4	4
	Max.	< 1.20	3.60 ± 1.10	290 ± 180
	Avg.	0.20 ± 0.33	2.23 ± 1.45	105 ± 133
HS	N	4	4	4
	Max.	< 1.40	2.10 ± 1.20	710 ± 260
	Avg.	0.40 ± 0.37	1.32 ± 0.76	239 ± 316
HT-E	N	4	4	4
	Max.	< 31*	< 18*	190 ± 120
	Avg.	2.26 ± 3.13	7.64 ± 6.99	85 ± 111
HT-W	N	4	4	4
	Max.	< 1.30	7.80 ± 1.60	< 200
	Avg.	0.19 ± 0.42	4.00 ± 3.37	75 ± 82
HW	N	4	4	4
	Max.	2.16 ± 0.90	< 34	260 ± 170
	Avg.	1.20 ± 1.16	7.83 ± 8.16	133 ± 100
HZ	N	4	4	4
	Max.	< 9.6	9.90 ± 1.30	< 170
	Avg.	0.79 ± 1.32	5.05 ± 4.01	48 ± 53
SDWA Limit		15	(a)	20,000

Notes:

See Figure 5-6 for the locations of recharge basins/outfalls.

All values reported with a 95% confidence interval.

Negative numbers occur when the measured value is lower than background (See Appendix B for description).

To convert values from pCi to Bq, divide by 27.03.

N = Number of samples analyzed

MDL = Minimum detection limit

SDWA = Safe Drinking Water Act

*A lower MDL could not be achieved due to the high solids content of the sample.

(a) The drinking water standard was changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in 2003.

As gross beta activity does not identify specific radionuclides, a dose equivalent of this value cannot be calculated.

beta activity are attributable to very low levels of naturally occurring radionuclides, such as potassium-40 (K-40). The contract analytical laboratory reported no gamma-emitting nuclides attributable to BNL operations for any discharges to recharge basins in 2004. Tritium was detected in a single sample collected at Basin

HS at very low levels (710 ± 260 pCi/L). Since there is no known source of tritium upstream of this basin, this detection is attributed to laboratory error.

5.4.2 Recharge Basins - Nonradiological Analyses

To determine the overall impact of the recharge basin discharges on the environment, the nonradiological analytical results were compared to groundwater discharge standards promulgated under Title 6 of the New York Codes, Rules, and Regulations, Part 703.6. Samples were collected quarterly for water quality parameters, metals, and VOCs, and analyzed by a contract laboratory. Field-measured parameters (pH, conductivity, and temperature) were routinely monitored and recorded. The water quality and metals analytical results are summarized in Tables 5-5 and 5-6, respectively.

Low concentrations of disinfection byproducts are periodically detected in several discharges. These VOCs included bromoform, chloroform, dibromochloromethane, and dichlorobromomethane. Concentrations ranged from nondetectable to a maximum of 5 µg/L. Sodium hypochlorite and bromine, used to control algae in cooling towers, were responsible for the formation of these compounds. Acetone and methylene chloride were the only analytes detected above minimum detection limits for most recharge basins and ranged from nondetectable to 20 µg/L. In most instances, acetone and methylene chloride were also found as contaminants in the contract analytical laboratory, as evidenced by detections in blank samples. Due to repeat detections of acetone and methylene chloride, an investigation of one of the contract analytical laboratories was conducted to determine if the detections were due to laboratory error during analysis. Blind blank samples (i.e., samples known to be free of contaminants) were shipped to the contract analytical laboratory for chemical analysis. All samples were returned with detections of methylene chloride and/or acetone. Assessment by the contract analytical laboratory revealed cross contamination between adjacent laboratory rooms. Corrective actions were implemented to prevent recurrence. The only other contaminant that was detected

Table 5-5. Water Quality Data for BNL On-site Recharge Basin Samples.

Recharge Basin		pH (SU)	Conductivity (µS/cm)	Temperature (°C)	Dissolved Oxygen	Chlorides	Sulfates	Nitrate as Nitrogen
					(mg/L)			
HN (RHIC)	N	4	4	4	4	4	4	4
	Min.	6.9	137	1.8	9.6	< 0.2	5.5	0.28
	Max.	7.9	340	14.2	12.8	63.9	20.3	0.64
	Avg.	NA	233	8.4	10.9	39.9	13.1	0.46
HO (AGS/HFBR)	N	4	4	4	4	4	4	4
	Min.	7.3	87	13.3	8.5	26	9.3	0.24
	Max.	7.5	2103	21.5	10.3	766	23	0.32
	Avg.	NA	624	19.1	9.2	211.4	13.3	0.28
HS (stormwater)	N	4	4	4	4	4	4	4
	Min.	7.2	167	6.6	9.1	27.5	10.2	0.11
	Max.	7.9	1650	21.8	11.7	50.6	14.9	0.95
	Avg.	NA	574	12	10.6	36.2	11.6	0.47
HT-W (Linac)	N	4	4	4	4	4	4	4
	Min.	7.3	168	9	8.5	29.2	8.5	0.2
	Max.	7.5	254	19.3	10.6	38.2	18.9	0.45
	Avg.	NA	201	13.2	9.6	32.5	13.4	0.3
HT-E (AGS)	N	4	4	4	4	4	4	4
	Min.	7.3	214	4.5	8.5	22.3	17.5	0.15
	Max.	7.6	3560	18.5	12.3	1330	36.9	1.02
	Avg.	NA	1178	10.1	10.1	358.0	23.2	0.54
HW (stormwater)	N	4	4	4	4	4	4	4
	Min.	7.1	83	2.8	8.6	3.8	4.2	0.38
	Max.	8	9772	26.2	11.9	2810	107	1.23
	Avg.	NA	2547	14.7	10.1	705.5	34.5	0.86
CSF (stormwater)	N	4	4	4	4	4	4	4
	Min.	6.6	105	0.9	7.9	4.1	6.4	0.22
	Max.	7.7	293	27.1	13.6	80.7	19.4	0.92
	Avg.	NA	187	14.8	10.2	27.8	13.5	0.59
HZ (stormwater)	N	4	4	4	4	4	4	4
	Min.	7.2	210	2.4	8.3	37.5	14.7	0.3
	Max.	7.7	1375	22	13.6	601	37.1	0.88
	Avg.	NA	613	12.8	10.8	204.1	24.9	0.55
NYSDEC Effluent Standard		6.5 – 8.5	SNS	SNS	SNS	500	500	10
Typical MDL		NA	NA	NA	NA	4	4	1

Notes:

See Figure 5-6 for the locations of recharge basins.

AGS/HFBR = Alternating Gradient Synchrotron/High Flux Beam Reactor

CSF = Central Steam Facility

Linac = Linear Accelerator

MDL = Minimum Detection Limit

N = Number of samples analyzed

NA = Not Applicable

NYSDEC = New York State Department of Environmental Conservation

RHIC = Relativistic Heavy Ion Collider

SNS = Effluent Standard Not Specified

Table 5-6. Metals Analyses of BNL On-Site Recharge Basin Samples.

Recharge Basin	No. of Samples	Ag µg/L	Al µg/L	As µg/L	Ba µg/L	Be µg/L	Cd µg/L	Co µg/L	Cr µg/L	Cu µg/L	Fe mg/L	Hg µg/L	Mn µg/L	Na mg/L	Ni µg/L	Pb µg/L	Sb µg/L	Se µg/L	Tl µg/L	V µg/L	Zn µg/L
HN (RHIC)	4	Min.	<2.0	318	1.5	11.8	<2.0	0.1	0.08	1.9	14.1	<0.2	17.4	16.2	1.9	1.2	1.3	1.7	<5.0	3	36.4
		Max.	<2.0	1940	6.2	26.9	<2.0	<5.0	<5.0	46.1	2.4	<0.2	41	46.2	3.9	11	<5.0	8	<5.0	6.4	99.3
		Avg.	<2.0	509.32	<5.0	22.52	<2.0	<2.0	<5.0	30.98	0.8	<0.2	28.25	32.03	3.28	3.75	<5.0	<5.0	<5.0	<5.0	71.75
HN (filtered) (RHIC)	2	Min.	<2.0	30.3	<5.0	23.5	<2.0	0.44	1.8	4.1	14.3	<0.2	12.6	26.5	3.3	0.33	1.3	1.4	<5.0	<5.0	32.1
		Max.	<2.0	<50.0	5.2	23.8	<2.0	0.91	6.3	<5.0	31.4	<0.2	25.7	45.8	3.9	<3.0	<5.0	6.4	<5.0	<5.0	79.1
		Avg.	<2.0	<50.0	<5.0	23.65	<2.0	0.68	4.05	<5.0	22.85	<0.2	19.15	36.15	3.6	<3.0	<5.0	3.9	<5.0	<5.0	55.6
HO (total) (AGS)	4	Min.	<2.0	<30.0	<5.0	16.5	0.71	0.08	0.07	1.8	1.4	<0.2	3.1	17	0.69	2.3	<5.0	<5.0	<5.0	1.7	4.9
		Max.	<2.0	426	<5.0	36.2	<2.0	<2.0	<5.0	<5.0	21.1	<0.2	156	410	3.8	3.8	<5.0	<5.0	<5.0	<5.0	75.1
		Avg.	<2.0	163.25	<5.0	24.1	<2.0	<2.0	<5.0	<5.0	6.68	<0.2	48.22	116.05	1.88	<3.0	<5.0	<5.0	<5.0	<5.0	28.68
HO (filtered) (AGS)	2	Min.	<2.0	<30.0	<5.0	15.5	<2.0	<2.0	1.2	<5.0	0.79	<0.2	2.4	18.6	0.71	<3.0	<5.0	<5.0	<5.0	<5.0	3.5
		Max.	<2.0	<30.0	<5.0	15.5	<2.0	<2.0	1.2	<5.0	0.79	<0.2	2.4	18.6	0.71	<3.0	<5.0	<5.0	<5.0	<5.0	3.5
		Avg.	<2.0	<30.0	<5.0	15.5	<2.0	<2.0	1.2	<5.0	0.79	<0.2	2.4	18.6	0.71	<3.0	<5.0	<5.0	<5.0	<5.0	3.5
HS (total) (stormwater)	4	Min.	<2.0	<50.0	<5.0	12.1	<2.0	<2.0	0.09	1	2.8	<0.2	7	18.9	1.6	2.6	<5.0	1.2	<5.0	0.72	12.9
		Max.	<2.0	307	<5.0	26.4	<2.0	<2.0	<5.0	6.1	<10.0	<0.2	11.6	28.9	<10.0	3.1	<5.0	<5.0	<5.0	<5.0	24.9
		Avg.	<2.0	214.25	<5.0	19.05	<2.0	<2.0	<5.0	<5.0	<10.0	<0.2	8.98	22.63	<10.0	<3.0	<5.0	<5.0	<5.0	<5.0	20.92
HS (filtered) (stormwater)	2	Min.	<2.0	28.9	0.94	14.8	<2.0	<2.0	1.9	3.7	2.2	<0.2	5.2	18.8	1.5	1	0.57	0.7	<5.0	<5.0	14
		Max.	<2.0	<50.0	<5.0	24	<2.0	<2.0	8.9	<5.0	4	<0.2	17.3	23.6	2.3	<3.0	<5.0	1.2	<5.0	<5.0	17
		Avg.	<2.0	<50.0	<5.0	19.4	<2.0	<2.0	5.4	<5.0	3.1	<0.2	11.25	21.2	1.9	<3.0	<5.0	0.95	<5.0	<5.0	15.5
HT-E (total) (AGS)	4	Min.	<2.0	39.5	<5.0	21.1	0.48	1.1	0.1	1.7	16.7	<0.2	20.9	23.6	3	2.5	<5.0	<5.0	0.49	3.3	45
		Max.	<2.0	3480	16.6	39.6	<2.0	<2.0	1.9	6.3	42.1	<0.2	92.9	1030	6.8	16.1	<5.0	25.1	<5.0	11.4	151
		Avg.	<2.0	929	8.88	26.52	<2.0	<2.0	0.65	<5.0	33.58	<0.2	44.1	284.27	4.32	6.08	<5.0	12.65	<5.0	<5.0	86.55
HT-E (filtered) (AGS)	2	Min.	<2.0	<50.0	9.9	19	<2.0	1.1	1.6	1.5	34.5	<0.2	13.5	35.2	2.3	1.6	1.3	11.8	<5.0	2.8	41.6
		Max.	<2.0	56.5	14.2	21.6	<2.0	1.4	6.6	2.5	36.3	<0.2	40.5	48.5	3.4	1.6	<5.0	12.5	<5.0	<5.0	58.4
		Avg.	<2.0	<50.0	12.05	20.3	<2.0	1.25	4.1	2	35.4	<0.2	27	41.85	2.85	1.6	<5.0	12.15	<5.0	<5.0	50
HT-W (total) (Linac)	4	Min.	<2.0	56.4	0.77	12.3	0.14	0.11	0.15	1.8	11.7	<0.2	5.4	19.8	2	0.62	<5.0	1.7	<5.0	2	17
		Max.	<2.0	214	<5.0	23.8	<2.0	3.3	<5.0	<5.0	271	<0.2	36.2	30.8	<10.0	<3.0	<5.0	<5.0	<5.0	<5.0	84.4
		Avg.	<2.0	103.35	<5.0	19.88	<2.0	<2.0	<5.0	<5.0	87.52	<0.2	24.45	22.98	<10.0	<3.0	<5.0	<5.0	<5.0	<5.0	40.78

(continued on next page)

Table 5-6. Metals Analyses of BNL On-Site Recharge Basin Samples (concluded).

Recharge Basin	No. of Samples	Ag µg/L	Al µg/L	As µg/L	Ba µg/L	Be µg/L	Cd µg/L	Co µg/L	Cr µg/L	Cu µg/L	Fe mg/L	Hg µg/L	Mn µg/L	Na mg/L	Ni µg/L	Pb µg/L	Sb µg/L	Se µg/L	Tl µg/L	V µg/L	Zn µg/L	
HT-W (filtered) (Linac)	2	Min.	<2.0	<50.0	3.6	19.7	<2.0	0.12	2	3.9	8	0.12	<0.2	11.7	19.1	2.6	0.52	<5.0	1.7	<5.0	<5.0	36.2
		Max.	<2.0	67.6	<5.0	25.7	<2.0	3	7.3	<5.0	250	0.12	<0.2	31.9	30.6	3.5	<3.0	<5.0	<5.0	<5.0	<5.0	69.5
		Avg.	<2.0	<50.0	<5.0	22.7	<2.0	1.56	4.65	<5.0	129	0.12	<0.2	21.8	24.85	3.05	<3.0	<5.0	<5.0	<5.0	<5.0	52.85
HW (total) (stormwater)	3	Min.	0.29	379	1.3	12.6	<2.0	0.46	0.5	2.5	15.9	0.56	0.13	28	3.74	3.3	6.8	0.64	<5.0	<5.0	7.3	46.1
		Max.	<2.0	4880	<5.0	43.8	<2.0	3.6	2.5	10.4	77.1	5.85	<0.2	65.1	4.48	10.6	110	<5.0	<5.0	<5.0	17.6	275
		Avg.	<2.0	2299.67	<5.0	23.67	<2.0	1.51	1.21	5.2	37.33	2.64	<0.2	41.23	4.15	6.37	42.87	<5.0	<5.0	<5.0	11.03	123.7
HW (filtered) (stormwater)	2	Min.	<2.0	74.3	0.67	7.4	<2.0	0.28	1.8	1.4	10.4	0.04	<0.2	8	3.96	2.5	1.6	0.76	<5.0	<5.0	1.9	15.6
		Max.	<2.0	81.4	<5.0	8.3	<2.0	0.3	8.5	3	13.6	0.07	<0.2	25.6	4.37	4.8	1.7	<5.0	<5.0	<5.0	6.8	34.7
		Avg.	<2.0	77.85	<5.0	7.85	<2.0	0.29	5.15	2.2	12	0.06	<0.2	16.8	4.16	3.65	1.65	<5.0	<5.0	<5.0	4.35	25.15
CSF (total) (stormwater)	3	Min.	<2.0	499	1.1	10.3	<2.0	0.12	1.2	2.2	7.7	1.01	<0.2	22.3	4.68	10.3	5.2	0.59	0.75	1.5	5.1	54.4
		Max.	<2.0	1020	1.4	20.4	<2.0	0.23	2.9	3.2	14.2	1.77	<0.2	77.9	25.2	42.1	6.6	<5.0	<5.0	<5.0	27.5	233
		Avg.	<2.0	712	1.2	15.2	<2.0	0.18	1.93	2.63	10.23	1.39	<0.2	42.7	11.68	23.67	5.9	<5.0	<5.0	<5.0	15.43	120.03
CSF (filtered) (stormwater)	2	Min.	<2.0	44.4	0.71	5.1	<2.0	0.09	2.6	2.9	3.8	0.04	<0.2	12.2	4.51	7.3	1.7	4.5	<5.0	<5.0	2.2	41.9
		Max.	<2.0	47.5	<5.0	14.9	<2.0	0.12	8.9	<5.0	3.8	0.08	<0.2	31.2	25.4	13.3	<3.0	<5.0	<5.0	<5.0	7.9	50.4
		Avg.	<2.0	45.95	<5.0	10	<2.0	0.1	5.75	<5.0	3.8	0.06	<0.2	21.7	14.96	10.3	<3.0	<5.0	<5.0	<5.0	5.05	46.15
HZ (total) (stormwater)	4	Min.	<2.0	28.6	1.5	22	0.45	0.53	0.24	4.2	10	0.14	<0.2	33.7	24.1	3.7	4.9	<5.0	0.97	0.89	<5.0	63.1
		Max.	<2.0	2790	9.2	45.2	<2.0	2.8	<5.0	6.9	86	2.96	<0.2	68.2	347	6.4	151	<5.0	9.1	<5.0	10.6	132
		Avg.	<2.0	714.12	<5.0	34.22	<2.0	<2.0	<5.0	<5.0	45.28	0.97	<0.2	56.03	128.33	4.82	51.9	<5.0	<5.0	<5.0	<5.0	105.78
HZ (filtered) (stormwater)	2	Min.	<2.0	18.2	<5.0	24.9	0.06	0.48	1.2	4	25.3	0.09	<0.2	15.5	24.3	3.8	3.1	<5.0	1.2	<5.0	<5.0	55.1
		Max.	<2.0	<30.0	9.8	39.9	<2.0	2.7	8.3	<5.0	46.4	0.3	<0.2	75.1	80.5	5.2	24.8	<5.0	10.8	<5.0	<5.0	60.6
		Avg.	<2.0	<30.0	<5.0	32.4	<2.0	1.59	4.75	<5.0	35.85	0.19	<0.2	45.3	52.4	4.5	13.95	<5.0	6	<5.0	<5.0	57.85
NYSDEC Effluent Limitation or AWQS																						
	50	2000	50	2000	SNS	10	5	100	1000	0.6	1.4	600	SNS	200	50	6	20	SNS	SNS	5000		
Typical MDL		1.0	2.2	3.0	1.8	0.7	1.1	0.1	1.0	2.0	0.015	0.2	2.0	1.0	1.1	1.3	0.9	5.0	0.7	5.5	4.0	

Notes:

See Figure 5-6 for locations of recharge basins.

AGS = Alternating Gradient Synchrotron

AWQS = Ambient Water Quality Standards

CSF = Central Steam Facility

Linac = Linear Accelerator

MDL = Minimum Detection Limit

NYSDEC = New State Department of Environmental Conservation

RHIC = Relativistic Heavy Ion Collider

SNS = Effluent Standard Not Specified

above the method detection limit was hexanone, in a single sample collected at the CSF. The source of this contaminant is unknown and is likely due to cross contamination of samples in the contract analytical laboratory.

The analytical data in Tables 5-5 and 5-6 show that all parameters, except for aluminum and iron, complied with the respective groundwater discharge or water quality standards. Chlorides were found to be higher in discharge samples collected during the winter and are attributed to road salt used to control snow and ice buildup. Iron and aluminum are natural components of soil and readily dissolve when water samples are acidified for preservation. Iron is also naturally present in Long Island groundwater at concentrations that exceed the New York State Groundwater Discharge Standard (GDS). Filtration of samples resulted in aluminum and iron concentrations that were less than the NYS AWQS or GDS, as appropriate. When the aluminum and iron are in particulate form, they pose no threat to groundwater quality, because the recharge basin acts as a natural filter, trapping the particles before they reach groundwater.

Lead at the CSF outfall continued to be evaluated in 2004. Installing a geotextile fabric at the spillway of the CSF outfall eliminated all instances of SPDES noncompliance. However, sediment is slowly accumulating on top of the fabric. These sediments have been tested and found to contain elevated levels of lead. The remedial plan previously in place was revised and resubmitted to the regulatory agencies in March 2004. The review is pending.

5.4.3 Stormwater Assessment

All recharge basins receive stormwater runoff. Stormwater at BNL is managed by collecting runoff from paved surfaces, roofs, and other impermeable surfaces and directing it to recharge basins via underground piping and abovegrade vegetated swales. Recharge Basin HS receives most of the stormwater runoff from the central, developed portion of the BNL site. Basins HN, HZ, HT-W, and HT-E receive runoff from the Collider–Accelerator Complex; Basin HO receives runoff from the areas around the Brookhaven Graphite Research Reactor

(BGRR) and HFBR; Basin CSF receives runoff from the area around the CSF and areas along Cornell Avenue east of Railroad Avenue; Basin HW receives runoff from the warehouse area; and HWM receives runoff from the fenced area at the former HWMF.

Stormwater runoff from the BNL site typically has elevated levels of inorganics and low pH. The inorganics are attributable to high sediment content and the natural occurrence of these elements in native soil. In an effort to further protect the quality of stormwater runoff, BNL has finalized formal procedures for managing and maintaining outdoor work and storage areas. The requirements include covering areas to prevent contact with stormwater, an aggressive maintenance and inspection program, and formal restoration of these areas when operations cease.

5.5 PECONIC RIVER SURVEILLANCE

Several locations are monitored along the Peconic River to assess the overall water quality of the river and any impact from BNL discharges. Sampling points along the Peconic River are identified in Figure 5-8. In total, 10 stations (three upstream and seven downstream of the STP) were scheduled for monitoring in 2004, although additional locations were sampled by field personnel. A sampling station along the Carmans River (HH) was also monitored as a geographic control location, not affected by BNL operations. All locations were routinely monitored for radiological and nonradiological parameters. The sampling stations are located as follows:

Upstream sampling stations

- HE, on site, approximately 20 feet upstream of the STP outfall (EA)
- HV, on site, just east of the 10 o'clock Experimental Hall in the RHIC ring
- HY, on site, immediately east of the William Floyd Parkway

Downstream sampling stations

- HM-N, on site, 0.5 mile downstream of the STP outfall
- HM-S, on site on a typically dry tributary of the Peconic River
- HQ, on site, 1.2 miles downstream of the

Figure 5-8. Sampling Stations for Surface Water, Fish, and Shellfish.

- STP outfall at the site boundary
- HA, first station downstream of the BNL boundary, 3.1 miles from the STP outfall
- Donahue's Pond, off site, 4.3 miles downstream of the STP outfall (Note: In 2004, some samples were collected at former station HC, due to access problems at Donahue's Pond. The two sites are near one another.)
- Forge Pond, off site

Control location

- HH, Carmans River
- Swan Pond, off site

5.5.1 Peconic River - Radiological Analyses

Radionuclide measurements were performed on surface water samples collected from the Peconic River at all 10 locations. Routine samples at Stations HM-N and HQ were collected once per month; all other stations were sampled quarterly unless conditions (such as no water flow) prevented collection. Stations HE, HM-N, and HQ have been equipped with Parshall flumes that allow automated flow-proportional sampling and volume measurements. All other sites were sampled by collecting instantaneous grab samples, as flow allowed.

The radiological data from Peconic River surface water sampling in 2004 are summarized in Table 5-7. Radiological analysis of upstream water samples showed that gross alpha and beta activity was detected at most Peconic River and Carmans River locations. The highest concentrations of gross beta were detected upstream of the BNL STP discharge at location HV, which is lo-

cated on site just inside the RHIC ring. However, the average concentrations from off-site and control locations are indistinguishable. The beta activity for all locations is therefore attributed to natural sources. Samples collected downstream of the STP discharge showed concentrations typical of STP releases and historical values. All detected levels were below the applicable DWS. Detections of gross alpha activity have high levels of error, indicating that these detections are indistinguishable from the minimum detection limit. No gamma-emitting radionuclides attributable to BNL operations were detected either upstream or downstream of the STP.

Tritium results for water samples collected upstream and downstream of the STP discharge were below detectable levels at all stations, except for a single detection of 370 ± 180 pCi/L at station HA, downstream of the BNL site boundary. The New York State DWS for tritium is 20,000 pCi/L.

Monitoring for Sr-90 was performed at nine of the 10 stations sampled in 2004. In 2004, the only positive detection for Sr-90 was at Station HY, upstream of all BNL operations, at a concentration of 0.96 ± 0.27 pCi/L. This concentration is consistent with historical levels and has been attributed to worldwide fallout. Cross contamination in the contract analytical laboratory resulted in high detection limits being reported for Sr-90 samples collected in February 2004. All results, both upstream and downstream of BNL, were similar, leading to the conclusion that there was no contribution from BNL operations.

Table 5-7. Radiological Results for Surface Water Samples Collected along the Peconic and Carmans Rivers.

Sample Station	Geographic Location		Gross Alpha	Gross Beta	Tritium	Sr-90
			(pCi/L)			
HY	Peconic River (headwaters) onsite, west of the RHIC ring	N	4	4	4	4
		Max.	< 2.9	7.20 ± 1.50	< 220	0.96 ± 0.27
		Avg.	1.08 ± 0.53	3.49 ± 2.47	83 ± 116	0.56 ± 0.41
HV	Peconic River (headwaters) onsite, inside the RHIC ring	N	4	4	4	NS
		Max.	< 5.3	9.50 ± 1.60	300 ± 160	
		Avg.	1.78 ± 2.20	5.18 ± 3.09	109 ± 130	

(continued on next page)

Table 5-7. Radiological Results for Surface Water Samples Collected along the Peconic and Carmans Rivers (concluded).

Sample Station	Geographic Location		Gross Alpha	Gross Beta	Tritium	Sr-90
			(pCi/L)			
HE	Peconic River, upstream of STP Outfall	N	4	4	4	3
		Max.	1.51 ± 0.86	4.70 ± 1.30	< 180	< 1.6
		Avg.	0.84 ± 0.50	3.15 ± 1.20	-5 ± 67	0.56 ± 0.68
HM-N	Peconic River, downstream of STP, on site	N	6	6	6	2
		Max.	2.30 ± 1.20	6.10 ± 1.30	< 261	< 0.41
		Avg.	0.81 ± 0.64	3.84 ± 1.10	91 ± 71	0.23 ± 0.27
HM-S	Peconic River tributary, on site	N	2	2	2	1
		Max.	< 0.83	6.00 ± 1.30	< 250	< 0.56
		Avg.	0.43 ± 0.58	4.15 ± 3.63	125 ± 29	NA
HQ	Peconic River, downstream of STP, at BNL site boundary	N	5	5	5	1
		Max.	< 1.30	3.70 ± 1.40	< 259	< 0.74
		Avg.	0.44 ± 0.36	3.15 ± 0.48	86 ± 108	NA
HA	Peconic River, off site	N	4	4	4	4
		Max.	< 0.73	4.10 ± 1.10	370 ± 180	< 2.53
		Avg.	0.07 ± 0.37	2.55 ± 1.30	89 ± 185	0.78 ± 1.15
HC	Peconic River, off site	N	3	3	3	3
		Max.	< 0.94	2.63 ± 0.92	200 ± 140	< 2.26
		Avg.	0.74 ± 0.25	1.78 ± 0.69	20 ± 177	0.87 ± 1.37
Donahue's Pond	Peconic River, off site	N	1	1	1	1
		Value	2.1 ± 5.0	1.1 ± 3.6	< 270	< 0.62
Forge Pond	Peconic River, off site	N	4	4	4	4
		Max.	< 1.0	2.40 ± 1.40	< 200	< 2.82
		Avg.	0.47 ± 0.21	1.43 ± 1.53	23 ± 95	0.85 ± 1.29
Swan Pond	Control location, off site	N	4	4	4	4
		Max.	1.45 ± 0.86	6.70 ± 1.50	< 310	< 2.39
		Avg.	0.64 ± 0.65	3.73 ± 2.27	83 ± 122	0.78 ± 1.07
HH	Carmans River Control location, off site	N	4	4	4	4
		Max.	< 1.0	3.00 ± 1.30	200 ± 140	< 2.30
		Avg.	0.17 ± 0.39	2.08 ± 1.18	28 ± 113	0.82 ± 0.98
SDWA Limit (pCi/L)			15	(a)	20,000	8

Notes:

See Figure 5-8 for sample station locations.

All values reported with a 95% confidence interval.

Negative numbers occur when the measured values are lower than background (See Appendix B for description).

To convert values from pCi to Bq, divide by 27.03.

N = Number of samples analyzed

NS = Not Sampled for this analyte

SDWA = Safe Drinking Water Act

(a) The drinking water standard was changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in 2003. Because gross beta activity does not identify specific radionuclides, a dose equivalent can not be calculated for the values in the table.

5.5.2 Peconic River - Nonradiological Analyses

Peconic River samples collected in 2004 were analyzed for water quality parameters (pH, temperature, conductivity, and dissolved oxygen), anions (chlorides, sulfates, and nitrates), metals, and VOCs. No VOCs above the MDL were detected in river water samples. The inorganic analytical data for the Peconic River and Carmans River samples are summarized in Tables 5-8 (water quality) and 5-9 (metals).

Peconic River water quality data collected upstream and downstream showed that water quality was consistent throughout the river system. These data were also consistent with that from the Carmans River control location (HH). Sulfates and nitrates tend to be slightly higher in samples collected immediately downstream of the STP discharge (Stations HM-N and HQ) and were consistent with the concentrations in the STP discharge. Chlorides were highest at upstream Station HY. A sample collected from Station HY in April measured 258 mg/L, most probably due to road salting and surface runoff and that station's proximity to William Floyd Parkway. There are no ambient water quality standards imposed for chloride discharges to surface water; however, NYSDEC imposes a

discharge limit of 500 mg/L for discharges to groundwater.

The pH measured at several locations was very low, due to the low pH of precipitation, groundwater, and the formation of humic acids from decaying organic matter. As spring rains mix with decaying matter, these acids decrease the already low pH of precipitation, resulting in a pH as low as 4.2 Standard Units. A discussion of precipitation monitoring is provided in Chapter 6 (see Section 6.7 for more detail).

Ambient water quality standards for metallic elements are based on their solubility state. Certain metals are only biologically available to aquatic organisms if they are in a dissolved or ionic state, whereas other metals are toxic in any form (i.e., dissolved and particulate combined). In 2004, the BNL Environmental Monitoring Program continued to assess water samples for both the dissolved and particulate form. Dissolved concentrations were determined by filtering the samples prior to acid preservation and analysis. Examination of the metals data showed that aluminum, cobalt, copper, iron, lead, silver, and zinc were present in concentrations at some locations that exceeded ambient water quality standards both upstream

Table 5-8. Water Quality Data for Surface Water Samples Collected along the Peconic and Carmans Rivers.

Sample Station	Geographic Location		pH (SU)	Conductivity (µS/cm)	Temp. (°C)	Dissolved Oxygen	Chlorides	Sulfates	Nitrates as Nitrogen
						(mg/L)			
HY	Peconic River (headwaters) on site, east of Wm. Floyd Pkwy.	N	4	4	4	4	4	4	4
		Min.	4.4	36	0.4	5.5	7.4	1.7	< 0.02
		Max.	11.2	762	21.4	8.6	258	8.9	0.19
		Avg.	NA	237	12.7	7.1	71.2	4.6	0.08
HE	Peconic River, upstream of STP Outfall	N	4	4	4	4	4	4	4
		Min.	5.1	81	3.6	8.8	10.1	1.8	< 0.02
		Max.	7.1	232	11	11.8	51.2	5.3	0.08
		Avg.	NA	131	7.9	10.2	22.6	3.4	0.02
HM-N	Peconic River, downstream of STP, on site	N	6	6	6	6	6	6	6
		Min.	6.1	142	0.2	9.6	23.6	7.8	2.01
		Max.	6.8	286	9	13.4	62.5	20.3	4.99
		Avg.	NA	208	4.9	11.1	40.1	12.0	3.53

(continued on next page)

Table 5-8. Water Quality Data for Surface Water Samples Collected along the Peconic and Carmans Rivers (concluded).

Sample Station	Geographic Location		pH	Conductivity	Temp.	Dissolved Oxygen	Chlorides	Sulfates	Nitrates as Nitrogen
			(SU)	(μS/cm)	(°C)	(mg/L)			
HM-S	Peconic River tributary, on site	N	2	2	2	2	2	2	2
		Min.	4.2	47	0.1	3.1	4.9	1.4	< 0.05
		Max.	4.5	77	18.7	9.8	5.3	4.1	< 0.05
		Avg.	NA	62	9.4	6.5	5.1	2.8	< 0.05
HQ	Peconic River, downstream of STP, at BNL site boundary	N	5	5	5	5	5	5	6
		Min.	6.1	123	0.1	3.2	20	6.5	0.16
		Max.	6.8	219	19.5	9.6	42.5	12.2	4.19
		Avg.	NA	172	7.2	6.7	30.5	9.0	1.77
HA	Peconic River, off site	N	4	4	4	4	4	4	4
		Min.	5.7	57	0.1	4.1	10.6	4.2	< 0.05
		Max.	7.2	161	24	8.8	24.9	10.9	1.49
		Avg.	NA	93	13.1	6.7	14.6	6.2	0.44
HC	Peconic River, off site	N	2	2	2	2	2	2	2
		Min.	5.8	73	1.6	5.2	11.5	3.2	< 0.05
		Max.	6.6	74	23.2	6.2	11.7	7.4	0.19
		Avg.	NA	74	12.4	5.7	11.6	5.3	0.09
Donahue's Pond	Peconic River, off site	N	1	1	1	1	1	1	1
		Value	6.4	74	11.7	8.5	10.9	5.1	< 0.02
Forge Pond	Peconic River, off site	N	4	4	4	4	4	4	4
		Min.	6.2	95	2.4	8.4	14.6	7.8	< 0.05
		Max.	8.5	136	25.8	10.3	18.9	12.9	0.36
		Avg.	NA	121	15.9	9.5	17.7	10.8	0.18
Swan Pond	Control location, off site	N	4	4	4	4	4	4	4
		Min.	5.4	63	2	2.3	9.8	10	< 0.02
		Max.	6.9	107	24.7	9.6	19.6	13.3	0.14
		Avg.	NA	81	14.4	6.4	13.9	11.6	< 0.05
HH	Carmans River control location, off site	N	4	4	4	4	4	4	4
		Min.	6.4	175	6.9	8.4	0.11	0.22	1.18
		Max.	6.8	195	21.3	10.1	43	13.5	1.74
		Avg.	NA	185	14.2	9.3	23.5	8.9	1.47
NYSDEC AWQS			6.5 – 8.5	SNS	SNS	> 4.0	250 (a)	250 (a)	10 (a)
Typical MDL			NA	NA	NA	NA	4.0	4.0	1.0

Notes:

See Figure 5-8 for sample station locations.

AWQS = Ambient Water Quality Standards

MDL = Minimum Detection Limit

N = Number of samples analyzed

NA = Not Applicable

NYSDEC = New York State Department of Environmental Conservation

SNS = Standard Not Specified

(a) Since there are no NYSDEC Class C Surface AWQS for these compounds, the AWQS for groundwater is provided, if specified.

Table 5-9. Metals Analyses in Surface Water Samples Collected along the Peconic and Carmans Rivers.

Sample Station	N	Ag µg/L	Al µg/L	As µg/L	Ba µg/L	Be µg/L	Cd µg/L	Co µg/L	Cr µg/L	Cu µg/L	Fe mg/L	Hg µg/L	Mn µg/L	Na mg/L	Ni µg/L	Pb µg/L	Sb µg/L	Se µg/L	Tl µg/L	V µg/L	Zn µg/L	
Peconic River																						
HY (total)	4	Min.	0.08	707	2.1	11.4	0.06	0.15	0.37	2.3	3.1	0.73	<0.2	16.5	6.35	1.6	2.7	1.6	1.8	0.84	1.1	15.1
		Max.	<2.0	1260	<5.0	18.6	<2.0	<2.0	1.1	5.6	<10.0	0.88	<0.2	181	149	2.3	7.3	<5.0	<5.0	<5.0	4.3	49.1
		Avg.	<2.0	944	<5.0	14.3	<2.0	<2.0	0.72	<5.0	<10.0	0.84	<0.2	74.82	43.56	1.88	4.78	<5.0	<5.0	<5.0	2.9	31.05
HY (dissolved)	2	Min.	<2.0	606	0.61	11.4	<2.0	0.12	3.4	2	4.4	0.59	<0.2	49.3	6.09	2	2.4	<5.0	1.2	<5.0	2.1	21.4
		Max.	<2.0	943	<5.0	15.3	<2.0	<2.0	6.1	<5.0	<10.0	0.64	<0.2	179	9.27	2.7	3.4	<5.0	<5.0	<5.0	<5.0	32.5
		Avg.	<2.0	774.5	<5.0	13.35	<2.0	<2.0	4.75	<5.0	<10.0	0.61	<0.2	114.15	7.68	2.35	2.9	<5.0	<5.0	<5.0	<5.0	26.95
HV (total)	1	Value	<2.0	793	<5.0	19.8	0.13	<2.0	1	2.7	3.4	1.27	<0.2	77.2	253	4.5	7.2	<5.0	1.7	<5.0	3	48.5
HV (dissolved)	1	Value	<2.0	149	<5.0	15	0.31	<2.0	2.2	0.97	2.9	0.24	<0.2	59.9	246	2.7	2.6	<5.0	<5.0	<5.0	0.85	32.7
HE (total)	4	Min.	0.05	265	1	10	0.13	0.04	0.38	0.71	0.98	0.6	<0.2	56	8.67	1.2	1.3	<5.0	<5.0	0.5	2.4	6.3
		Max.	<2.0	390	<5.0	17.1	<2.0	<2.0	<5.0	<5.0	<10.0	6.32	<0.2	147	28.5	<10.0	<3.0	<5.0	<5.0	<5.0	<5.0	14.5
		Avg.	<2.0	322.25	<5.0	12.92	<2.0	<2.0	<5.0	<5.0	<10.0	3.8	<0.2	105.08	14.32	<10.0	<3.0	<5.0	<5.0	<5.0	<5.0	10.8
HE (dissolved)	2	Min.	<2.0	190	<5.0	9.2	0.13	<2.0	2.3	4.7	0.73	1.45	<0.2	99.7	9.02	1.5	0.88	<5.0	<5.0	<5.0	<5.0	10.3
		Max.	<2.0	312	<5.0	10.7	<2.0	<2.0	8.8	<5.0	<10.0	2.12	<0.2	120	9.71	2.4	<3.0	<5.0	<5.0	<5.0	<5.0	22.5
		Avg.	<2.0	251	<5.0	9.95	<2.0	<2.0	5.55	<5.0	<10.0	1.78	<0.2	109.85	9.36	1.95	<3.0	<5.0	<5.0	<5.0	<5.0	16.4
HM-N (total)	6	Min.	1.3	98.7	0.86	14	0.11	0.15	0.62	1.9	18	0.18	0.1	7.7	17.9	2	1.5	<5.0	0.87	<5.0	1.4	20.2
		Max.	3.6	569	<5.0	25.2	<2.0	<2.0	<5.0	5.1	34.4	1.07	<0.2	71.4	39.8	13.6	3.9	<5.0	<5.0	<5.0	4.1	64.6
		Avg.	1.98	348.45	<5.0	17.62	<2.0	<2.0	<5.0	<5.0	26.3	0.68	<0.2	31.98	31	<10.0	<3.0	<5.0	<5.0	<5.0	2.6	39.67
HM-N (dissolved)	3	Min.	0.27	149	1.1	11.7	<2.0	0.11	0.46	1.2	13.8	0.25	<0.2	20.6	17	2	0.97	<5.0	0.61	<5.0	1.5	24.9
		Max.	0.61	253	<5.0	25	<2.0	<2.0	8.6	4.4	32.3	0.74	<0.2	48.1	41.1	2.8	2.2	<5.0	<5.0	<5.0	<5.0	78.4
		Avg.	0.46	185	<5.0	16.63	<2.0	<2.0	3.79	2.5	21.8	0.44	<0.2	33.13	28.03	2.47	1.42	<5.0	<5.0	<5.0	<5.0	44.5
HM-S (total)	2	Min.	<2.0	443	<5.0	7	0.08	0.08	0.23	<5.0	<10.0	0.24	<0.2	23.8	2.79	3	1.6	<5.0	0.77	<5.0	0.89	18.5
		Max.	<2.0	1010	<5.0	16.4	<2.0	<2.0	<5.0	5.1	<10.0	1.93	<0.2	32	2.85	<10.0	2	<5.0	<5.0	<5.0	1.4	65.7
		Avg.	<2.0	726.5	<5.0	11.7	<2.0	<2.0	<5.0	<5.0	<10.0	1.08	<0.2	27.9	2.82	<10.0	1.8	<5.0	<5.0	<5.0	1.14	42.1
HM-S (dissolved)	1	Value	<2.0	951	<5.0	13.3	0.05	0.13	10.2	6	2.2	1.85	<0.2	35.6	3.07	3.6	2.1	<5.0	0.91	<5.0	<5.0	87.4
HQ (total)	5	Min.	0.46	91.5	1.5	9.1	0.06	0.17	0.52	0.99	11.8	0.26	0.04	4.4	16.5	2.2	1.3	<5.0	0.82	<5.0	1.7	21.9
		Max.	1.3	392	<5.0	14.6	<2.0	<2.0	<5.0	5.2	25.1	0.88	<0.2	49.6	28.9	<10.0	2.2	<5.0	<5.0	<5.0	4.3	47.2
		Avg.	0.81	201.5	<5.0	11.1	<2.0	<2.0	<5.0	2.34	15.82	0.49	<0.2	34.84	23.28	<10.0	1.66	<5.0	<5.0	<5.0	2.42	35.54

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Table 5-9. Metals Analyses in Surface Water Samples Collected along the Peconic and Carmans Rivers (continued).

Sample Station	N	Ag µg/L	Al µg/L	As µg/L	Ba µg/L	Be µg/L	Cd µg/L	Co µg/L	Cr µg/L	Cu µg/L	Fe mg/L	Hg µg/L	Mn µg/L	Na mg/L	Ni µg/L	Pb µg/L	Sb µg/L	Se µg/L	Tl µg/L	V µg/L	Zn µg/L
HQ (dissolved)	3	Min.	0.33	76.2	1.3	7.1	<2.0	0.12	1.3	2	9.9	<0.2	6.4	16.4	3.2	0.79	<5.0	0.54	<5.0	1.1	22.4
		Max.	<2.0	202	<5.0	13.6	<2.0	<2.0	7.7	5.1	24.3	<0.2	46	28.7	3.7	1.5	<5.0	<5.0	<5.0	1.9	45.5
		Avg.	<2.0	132.4	<5.0	9.43	<2.0	<2.0	3.7	3.13	15.7	<0.2	32.6	23.93	3.43	1.16	<5.0	<5.0	<5.0	1.57	30.4
HA (total)	4	Min.	0.28	<50.0	2.3	7.1	0.43	0.07	0.19	0.99	1.3	0.01	19.8	6.55	0.98	0.75	<5.0	0.86	0.71	1.7	4.9
		Max.	<2.0	121	<5.0	10.2	<2.0	<2.0	<5.0	<5.0	<10.0	<0.2	45.4	21.4	<10.0	<3.0	11.9	<5.0	<5.0	<5.0	14.4
		Avg.	<2.0	70.68	<5.0	8.72	<2.0	<2.0	<5.0	<5.0	<10.0	<0.2	34.7	11.46	<10.0	<3.0	<5.0	<5.0	<5.0	<5.0	9.4
HA (dissolved)	2	Min	0.19	24.8	0.8	8.2	<2.0	0.07	2	1.7	2.8	<0.2	21.4	8.17	1.3	0.62	<5.0	0.7	<5.0	<5.0	10.1
		Max.	<2.0	119	2	8.6	<2.0	<2.0	2.4	<5.0	4.4	<0.2	44.8	21.4	2.9	<3.0	<5.0	<5.0	<5.0	<5.0	13.3
		Avg.	<2.0	71.9	1.4	8.4	<2.0	<2.0	2.2	<5.0	3.6	<0.2	33.1	14.78	2.1	<3.0	<5.0	<5.0	<5.0	<5.0	11.7
HC (total)	2	Min.	<2.0	<50.0	<5.0	11	<2.0	<2.0	0.13	<5.0	0.9	<0.2	50.7	7.29	0.66	1.2	<5.0	<5.0	0.87	0.63	7.5
		Max.	<2.0	75.6	<5.0	13.8	<2.0	<2.0	<5.0	<5.0	<10.0	<0.2	186	8.24	<10.0	2.5	<5.0	<5.0	<5.0	<5.0	10
		Avg.	<2.0	<50.0	<5.0	12.4	<2.0	<2.0	<5.0	<5.0	<10.0	<0.2	118.35	7.76	<10.0	1.85	<5.0	<5.0	<5.0	<5.0	8.75
Donohue's Pond (total)	1	Value	<2.0	<50.0	1.6	9.6	<2.0	<2.0	0.08	<5.0	0.86	<0.2	39.2	8.21	0.54	<3.0	<5.0	<5.0	<5.0	<5.0	<10.0
Donohue's Pond (dissolved)	1	Value	<2.0	<50.0	0.9	8.5	<2.0	<2.0	2.5	<5.0	0.54	<0.2	42.2	8.03	0.89	<3.0	1.2	<5.0	<5.0	<5.0	6.1
Swan Pond (total)	4	Min.	<2.0	<50.0	0.78	8.4	<2.0	<2.0	0.05	1.7	1.3	<0.2	64.9	6.72	0.64	1.3	<5.0	0.64	<5.0	0.89	4.9
		Max.	<2.0	144	<5.0	14.5	<2.0	<2.0	<5.0	<5.0	<10.0	<0.2	442	11.6	<10.0	3	<5.0	<5.0	<5.0	<5.0	13
		Avg.	<2.0	84.45	<5.0	11.1	<2.0	<2.0	<5.0	<5.0	<10.0	<0.2	208.88	9.34	<10.0	<3.0	<5.0	<5.0	<5.0	<5.0	7.25
Swan Pond (dissolved)	2	Min.	<2.0	38.1	<5.0	7.1	<2.0	0.05	3.6	1.5	1.3	<0.2	33.7	6.8	1	<3.0	<5.0	0.67	<5.0	<5.0	13.4
		Max.	<2.0	<50.0	<5.0	10.5	<2.0	<2.0	7.5	<5.0	2.7	<0.2	384	9.7	1.5	<3.0	<5.0	<5.0	<5.0	<5.0	14.5
		Avg.	<2.0	<50.0	<5.0	8.8	<2.0	<2.0	5.55	<5.0	2	<0.2	208.85	8.25	1.25	<3.0	<5.0	<5.0	<5.0	<5.0	13.95

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Table 5-9. Metals Analyses in Surface Water Samples Collected along the Peconic and Carmans Rivers (concluded).

Sample Station	N	Ag µg/L	Al µg/L	As µg/L	Ba µg/L	Be µg/L	Cd µg/L	Co µg/L	Cr µg/L	Cu µg/L	Fe mg/L	Hg µg/L	Mn µg/L	Na mg/L	Ni µg/L	Pb µg/L	Sb µg/L	Se µg/L	Tl µg/L	V µg/L	Zn µg/L
Forge Pond (total)	4 Min.	<2.0	46.7	0.77	16.1	0.53	<2.0	0.06	0.76	1.1	0.23	<0.2	15.5	9.76	0.49	0.72	<5.0	1.6	1.5	0.97	3.7
	Max.	<2.0	81.7	<5.0	21.2	<2.0	<2.0	0.95	<5.0	<10.0	1.05	<0.2	146	13.7	<10.0	<3.0	<5.0	<5.0	<5.0	<5.0	<10.0
	Avg.	<2.0	<50.0	<5.0	18.02	<2.0	<2.0	0.32	<5.0	<10.0	0.75	<0.2	65.4	12.07	<10.0	<3.0	<5.0	<5.0	<5.0	<5.0	<10.0
Forge Pond (dissolved)	2 Min.	<2.0	<50.0	1	14.3	<2.0	<2.0	2.6	1.5	0.64	0.16	<0.2	19.3	9.71	1.1	0.57	<5.0	<5.0	<5.0	<5.0	9
	Max.	<2.0	75.5	1.6	15.3	<2.0	<2.0	7.1	<5.0	2	0.74	<0.2	75.9	13.2	1.3	<3.0	<5.0	<5.0	<5.0	<5.0	9.4
	Avg.	<2.0	<50.0	1.3	14.8	<2.0	<2.0	4.85	<5.0	1.32	0.45	<0.2	47.6	11.46	1.2	<3.0	<5.0	<5.0	<5.0	<5.0	9.2
Carmans River (control locations)																					
HH (total)	4 Min.	<2.0	<50.0	0.89	30.9	0.38	<2.0	0.08	2.3	0.4	0.38	<0.2	41	17.6	0.64	1.5	<5.0	1.7	<5.0	1.8	5.6
	Max.	<2.0	610	<5.0	40.9	<2.0	<2.0	<5.0	<5.0	<10.0	1.41	<0.2	131	24.5	<10.0	6.2	<5.0	<5.0	<5.0	<5.0	15.1
	Avg.	<2.0	194.55	<5.0	37.08	<2.0	<2.0	<5.0	<5.0	<10.0	0.78	<0.2	92.1	19.8	<10.0	<3.0	<5.0	<5.0	<5.0	<5.0	<10.0
HH (dissolved)	2 Min.	<2.0	31	0.94	28.7	<2.0	<2.0	2.4	1.5	0.43	0.16	<0.2	59.3	16.6	1	<3.0	<5.0	<5.0	<5.0	<5.0	9.3
	Max.	<2.0	<50.0	<5.0	29.2	<2.0	<2.0	6.9	<5.0	<10.0	0.23	<0.2	84.5	18.4	1.1	<3.0	<5.0	<5.0	<5.0	<5.0	16.2
	Avg.	<2.0	<50.0	<5.0	28.95	<2.0	<2.0	4.65	<5.0	<10.0	0.19	<0.2	71.9	17.5	1.05	<3.0	<5.0	<5.0	<5.0	<5.0	12.75
NYSDEC AWQS	0.1	100	150	SNS	11	1.1	1.1	5	34	4	0.3	0.2	SNS	SNS	23	1.4	SNS	4.6	8	14	34
Solubility State	I	I	D		AS	D	D	AS	D	D	AS	D			D	D		D	AS	AS	D
Typical MDL	2	50	5	1.8	2	2	2	5	5	10	0.075	0.2	2	1	1.1	3	5	5	5	5	10

Notes:

See Figure 5-8 for sample station locations.

AWQS = Ambient Water Quality Standards

AS = Acid Soluble

D = Dissolved

I = Ionic

MDL = Minimum Detection Limit

N = Number of samples analyzed

NYSDEC = New York State Department of Environmental Conservation

SNS = Standard Not Specified for these elements for Class C Surface Waters

and downstream of the STP discharge, and/or at the control location HH. Aluminum and iron are detected throughout the Peconic and Carmans Rivers at concentrations that exceed the NYS AWQS in both the filtered and unfiltered fractions. Both are found in high concentrations in native Long Island soil and, for iron, at high levels in groundwater. The low pH of groundwater and precipitation contribute to the dissolution of these elements. Lead was detected at the highest levels in samples collected at the upstream station (HY). Upstream levels of lead are likely the result of stormwater runoff from nearby William Floyd Parkway. This is most likely due to historic use of leaded gasoline. Copper, silver, and zinc were at their highest concentrations immediately downstream of the STP discharge (HM-N). Although the NYS AWQS limits for copper, silver, and zinc are extremely restrictive, the NYS-granted SPDES permit allows higher STP discharge limits. All concentrations found at the downstream location were within the SPDES limits. Cobalt was detected only in filtered samples and is likely due to contamination by the filter media itself. With the exception of aluminum and iron, filtering the samples reduced concentrations of most metals to below the NYS AWQS, indicating that most detections were due to sediment carryover.

In 2004, BNL embarked on an extensive project to remediate Peconic River sediments containing contaminants such as mercury and silver. The goal of the project is to remove metal deposits, predominantly mercury, that could move into the food-chain and pose a risk for human consumption. The project began immediately downstream of the STP discharge and continued off site into the county parks immediately east of BNL's site boundary. The project includes excavation of between 6 and 12 inches of sediment from the river bottom. Once remediation is completed, future monitoring of river water, sediment, vegetation, and fish samples will determine the effectiveness of this project.

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Natural and Cultural Resources

The Brookhaven National Laboratory (BNL) Natural Resource Management Program is designed to protect and manage flora and fauna and the ecosystems in which they exist. The Laboratory's natural resource management strategy is based on an understanding of the site's resources and on maintaining compliance with applicable regulations. The goals of the program include protecting and monitoring the ecosystem, conducting research, and communicating with staff and the public on ecological issues. BNL focuses on protecting New York State threatened and endangered species on site, as well as continuing the Laboratory's leadership role within the greater Long Island Central Pine Barrens ecosystem.

Monitoring to determine whether current or historical activities are affecting natural resources is also part of this program. In 2004, deer and fish sampling results were consistent with previous years. Vegetables grown in the BNL garden plot continue to support historical analyses that there are no Laboratory-generated radionuclides in produce grown on site.

Completing the fourth year of managing the Upton Ecological and Research Reserve, its technical advisory group approved funding for research on the 530-acre area. Multiple research grants to investigate important local ecological issues were awarded and are discussed in this chapter.

The overriding goal of the BNL Cultural Resource Management Program is to ensure that proper stewardship of BNL and DOE historic resources is established and maintained. Additional goals of the program include maintaining compliance with various historic preservation and archeological laws and regulations, and ensuring the availability of identified resources to on-site personnel and the public for research and interpretation. A BNL Cultural Resource Management Plan has been developed to identify, assess, and document BNL's historic and cultural resources. In 2004, two archeological surveys were completed.

6.1 NATURAL RESOURCE MANAGEMENT PROGRAM

The purpose of the Natural Resource Management Program at BNL is to promote stewardship of the natural resources found at the Laboratory, as well as to integrate natural resource management and protection with BNL's scientific mission. To meet this purpose, the Laboratory completed and issued the *Natural Resource Management Plan for Brookhaven National Laboratory (NRMP)* (BNL 2003a). The NRMP describes the program strategy, ele-

ments, and planned activities for managing the various resources found on site. The plan and related information about natural resources at the Laboratory can be found at <http://www.bnl.gov/esd/wildlife/>.

6.1.1 Identification and Mapping

An understanding of the environmental baseline is the foundation of natural resource management planning. In 2004, BNL updated the vegetation map that was produced through funding managed by the U.S. Fish & Wildlife

Service (FWS). The update is a continuous process in which “ground truthing” (ground-based verification) of the map produces minor changes that more accurately reflect the actual vegetation present. Using a geographical information system (GIS), BNL staff produced a map overlay that clearly identifies the major vegetation complexes on site (Figure 6-1). In addition to the vegetation map, overlays for soil types and the locations of wetlands, other natural resource elements, and monitoring stations were added to BNL’s GIS system. These tools enable resource managers to track changes over time, detect interactions between components of the ecosystem, and identify the locations of management activities on the 5,265-acre property.

A wide variety of vegetation, birds, reptiles, amphibians, and mammals inhabit the BNL site. Through implementation of the NRMP, additional endangered, threatened, and species of special concern have been identified as having been resident at BNL within the past 30 years. The only New York State endangered species confirmed as now inhabiting BNL property is the eastern tiger salamander (*Ambystoma t. tigrinum*). Additionally, the New York State endangered Persius duskywing butterfly (*Erynnis p. persius*) and the crested fringed orchid (*Plantathera cristata*) have been identified on the BNL site in the past. Four New York State threatened species have been positively identified on site and two other species

Legend

- Red Maple - Blackgum Wet Forest
- Red Maple-Mesic Heath Forest
- Red Maple/Scarlet Oak-Mesic Heath Forest
- Pitch Pine/ White Oak Forest
- Pitch Pine/Mixed Oak- Heath Forest
- Planted White Pine Forest
- Black Cherry Forest
- Scarlet Oak-Heath Forest
- Road
- Successional
- Cattail Marsh
- Water
- Building
- Disturbed
- Grass
- Parking Lot

Figure 6-1. Vegetation Map of BNL.

are considered likely to be present. The banded sunfish (*Enneacanthus obesus*), the swamp darter fish (*Etheostoma fusiforme*), and the stiff goldenrod plant (*Solidago rigida*) have been previously reported (BNL 2000). The northern harrier (*Circus cyaneus*) was seen hunting over open fields in November 2003. The frosted elfin butterfly (*Callophrys irus*) has been identified as possibly being at BNL, based on historic documentation and the presence of its preferred habitat and host plant (wild lupine). In addition, stargrass (*Aletris farinosa*) has historically been found and is likely to persist. Several other species that either inhabit the BNL site, visit during migration, or have historically been identified at BNL, are listed as rare, species of special concern, or exploitably vulnerable by New York State (see Table 6-1).

6.1.2 Habitat Protection and Enhancement

BNL has precautions in place to protect on-site habitats and natural resources. Activities to eliminate or minimize negative effects on sensitive or critical species are either incorporated into BNL procedures or into specific program or project plans. Environmental restoration efforts remove pollutant sources that could contaminate habitats. Human access to critical habitats is limited. In some cases, habitats are enhanced to improve survival or increase populations. Routine activities that may affect habitat (such as road maintenance) are not undertaken until they have been duly evaluated.

6.1.2.1 Eastern Tiger Salamander Efforts

To safeguard eastern tiger salamander breeding areas, a map of these locations is reviewed when new projects are proposed. Distribution of the map is limited, to protect the salamander from exploitation by collectors and the pet trade. The map is updated annually as new information concerning eastern tiger salamanders is generated through research and monitoring. Other efforts to protect this state endangered species include determining when adult salamanders are migrating toward breeding locations, when metamorphosis has been completed, and when juveniles are migrating after metamorphosis. During these times, construction and

Table 6-1. New York State Threatened, Endangered, Exploitably Vulnerable, and Species of Special Concern at BNL.

Common Name	Scientific Name	State Status
Insects		
Frosted elfin	<i>Callophrys iris</i>	T
Mottled duskywing	<i>Erynnis martialis</i>	SC
Persius duskywing	<i>Erynnis persius persius</i>	E
Fish		
Banded sunfish	<i>Enneacanthus obesus</i>	T
Swamp darter	<i>Etheostoma fusiforme</i>	T
Amphibians		
Eastern tiger salamander	<i>Ambystoma tigrinum tigrinum</i>	E
Marbled salamander	<i>Ambystoma opacum</i>	SC
Eastern spadefoot toad	<i>Scaphiopus holbrooki</i>	SC
Reptiles		
Spotted turtle	<i>Clemmys guttata</i>	SC
Eastern hognose snake	<i>Heterodon platyrhinos</i>	SC
Eastern box turtle	<i>Terrapene carolina</i>	SC
Worm snake	<i>Carphophis amoenus</i>	SC
Birds (nesting or common)		
Cooper's hawk	<i>Accipiter cooperii</i>	SC
Grasshopper sparrow	<i>Ammodramus savannarum</i>	SC
Whip-poor-will	<i>Caprimulgus vociferus</i>	SC
Northern harrier	<i>Circus cyaneus</i>	T
Horned lark	<i>Eremophila alpestris</i>	SC
Vesper sparrow	<i>Poocetes gramineus</i>	SC
Plants		
Stargrass	<i>Aletris farinosa</i>	T
Butterfly weed	<i>Asclepias tuberosa</i>	V
Spotted wintergreen	<i>Chimaphila maculata</i>	V
Flowering dogwood	<i>Cornus florida</i>	V
Pink lady's slipper	<i>Cypripedium acaule</i>	V
Winterberry	<i>Ilex verticillata</i>	V
Sheep laurel	<i>Kalmia angustifolia</i>	V
Narrow-leafed bush clover	<i>Lespedeza angustifolia</i>	R
Ground pine	<i>Lycopodium obscurum</i>	V
Bayberry	<i>Myrica pensylvanica</i>	V
Cinnamon fern	<i>Osmunda cinnamomera</i>	V
Clayton's fern	<i>Osmunda claytoniana</i>	V
Royal fern	<i>Osmunda regalis</i>	V
Crested fringed orchid	<i>Plantathera cristata</i>	E
Long-beaked bald-rush	<i>Rhynchospora scirpoides</i>	R
Swamp azalea	<i>Rhododendron viscosum</i>	V
Stiff goldenrod	<i>Solidago rigida</i>	T
New York fern	<i>Thelypteris novaboracensis</i>	V
Marsh fern	<i>Thelypteris palustris</i>	V
Virginia chain-fern	<i>Woodwardia virginica</i>	V

Notes:

Table information is based on 6 NYCRR Part 182, 6 NYCRR Part 193, and BNL survey data.

No federally listed Threatened or Endangered

Species are known to inhabit the BNL site.

E = Endangered

R = Rare

SC = Species of Special Concern

T = Threatened

V = Exploitably Vulnerable

maintenance activities near eastern tiger salamander habitats are postponed. BNL environmental protection staff must review any project planned near eastern tiger salamander habitats, and every effort is made to minimize impacts.

Water quality testing is conducted as part of the routine monitoring of recharge basins, as discussed in Chapter 5. In cooperation with the New York State Department of Environmental Conservation (NYSDEC), habitat surveys have been conducted annually since 1999. Biologists conducting egg mass and larval surveys have increased the number of confirmed sites from 17 on-site ponds to 22 ponds that are used by eastern tiger salamanders. The study procedure calls for all ponds that had egg masses during the spring surveys to be surveyed again in June and July to check for the presence of larval salamanders. Egg mass surveys of 26 ponds plus additional flooded depressions at BNL were conducted in 2004. Interns working through the Science Undergraduate Laboratory Intern Program offered by DOE and BNL's Office of Education conducted surveys of tiger salamander ponds and conducted drift fence surveys on three ponds. The results of these studies show the extent of egg mass production, and the importance of precipitation as a trigger for metamorphic salamanders leaving ponds. The success of these surveys has resulted in further interest by NYSDEC and researchers at SUNY Binghamton. Work toward a comprehensive understanding of eastern tiger salamander movements and habitat needs began in 2004 with funding provided to SUNY Binghamton by NYSDEC. Information acquired from all research is entered into a database and portions of the data are linked to a GIS. These data are used to visualize distributions, track reproductive success, and identify areas for focused management or study.

6.1.2.2 Eastern Hognose Snake

In 2003, a radio telemetry study of the eastern hognose snake (*Heterodon platyrhinos*) was initiated. This species of special concern was considered to be very rare on Long Island. Reports of the snake were spotty through 1995, with no reports from Long Island between 1995

and 2001. In 2002, five sightings of this snake occurred at BNL, with photo documentation for two of the sightings. The presence of the snake at BNL raised interest as to the health of the population, and a FWS biologist with the Upton Reserve began looking for the snake in order to conduct radio telemetry studies and determine habitat use. Six snakes were captured by the end of May 2003. Veterinarians from the Wildlife Conservation Society (Bronx Zoo) surgically implanted radio transmitters into five of the snakes. The snakes were held for several days to recover from surgery before being released. The snakes were routinely followed throughout the summer of 2003, and location and habitat data were recorded each time the snakes were found. Early in the project, two snakes could not be located. Information gained from the remaining three snakes provided biologists with a better understanding of this snake's movement and habitat use. It was originally thought that the eastern hognose snake preferred open sandy habitats. Results of the study now suggest that the snake utilizes multiple habitats that include sandy open areas, grassy areas, and forest habitats. During the summer months, additional sightings of eastern hognose snakes occurred. A total of 17 individual snakes were documented in 2003 and permanently identified by implanting a passively induced transponder subcutaneously, just forward of their tails.

In 2004, the radio telemetry program was expanded to eight snakes. During spring 2004, biologists retrieved the three snakes from 2003 and collected five additional snakes. Veterinarians from the Bronx Zoo implanted the transmitters and the snakes were released. An intern tracked snakes throughout the summer and a report was written concerning the snakes' movements and the biological observations that were made. The project will continue for one additional year in 2005, after which results will be published in the scientific literature.

6.1.2.3 Other Species

As part of the eastern tiger salamander and herpetological surveys, information is being gathered on other species. Including the tiger salamander (see Section 6.1.2.1), sightings of

a total of 26 species of reptiles and amphibians were recorded. The species observed include the northern red-back salamander (*Plethodon c. cinereus*), marbled salamander (*Ambystoma opacum*), four-toed salamander (*Hemidactylium scutatum*), red-spotted newt (*Notophthalmus viridescens*), spring peeper (*Pseudacris crucifer*), wood frog (*Rana sylvatica*), gray tree frog (*Hyla versicolor*), bullfrog (*Rana catesbiana*), green frog (*Rana clamitans*), pickerel frog (*Rana palustris*), Fowler's toad (*Bufo woodhousei fowleri*), eastern spadefoot toad (*Scaphiopus holbrooki*), snapping turtle (*Chelydra serpentina*), painted turtle (*Chrysemys p. picta*), musk turtle (*Sternotherus odoratus*), spotted turtle (*Clemmys guttata*), eastern box turtle (*Terrapene carolina*), eastern hognose snake (*Heterodon platyrhinos*), northern black racer (*Coluber constrictor*), eastern ribbon snake (*Thamnophis s. sauritus*), eastern garter snake (*Thamnophis s. sirtalis*), northern water snake (*Nerodia s. sipedon*), northern ring-necked snake (*Diadophis punctatus edwardsi*), brown snake (*Storeria d. dekayi*), and the northern red-bellied snake (*Storeria occipitomaculata*). In addition, the eastern worm snake (*Carphophis amoenus*), a species of special concern, was found during summer 2004. This listing indicates that BNL has one of the most diverse herpetofaunal assemblages on Long Island.

Banded sunfish protection efforts include observing whether adequate flow in the Peconic River is maintained within areas currently identified as sunfish habitat, ensuring that existing vegetation in the sunfish habitat is not disturbed, and evaluating all river remediation efforts for potential impacts on these habitats. The Peconic River cleanup project was initiated in 2004. Prior to dewatering the on-site portions of the river, an effort was made to capture and relocate banded sunfish. From late April through July, 147 sunfish were captured on site and moved to a protected location. When the off-site portion of the Peconic River cleanup began, an additional 46 sunfish were captured and moved for protection. The sunfish will be re-introduced to the river once sufficient vegetative cover has been established.

A total of 216 species of birds have been identified at BNL since 1948, of which at least 85 are known to nest on site. Some of these nesting birds have shown declines in their populations nationwide over the past 30 years. The Laboratory conducts routine monitoring of songbirds along six permanent bird survey routes in various habitats on site. In 2004, monthly surveys were conducted, starting at the end of March and extending through the end of September. These surveys resulted in the identification of 68 species, compared to 79 during 2003. Two new species were identified during the surveys, and a total of 108 species having been identified during surveys in the past 5 years; 45 of these species were present each year. Variations in the number and species identified may be the result of the time of sampling, variations in weather patterns between years, or actual changes in the environment. The two most diverse transects pass near wetlands by the Biology Fields and the Peconic River. The four transects passing through the various forest types (white pine, moist pine barrens, and dry pine barrens) showed a less diverse bird community. Trends in the data indicate a slight decline in the number of species detected on each transect annually. Data are stored in an electronic database that is linked to BNL's GIS.

The eastern bluebird (*Sialia sialis*) has been identified as one of the declining species of migratory birds in North America. This decline is due to loss of habitat and to nest site competition from European starlings (*Sturnus vulgaris*) and house sparrows (*Passer domesticus*). BNL's NRMP calls for habitat enhancement. Since 2000, BNL has installed 48 nest boxes around open grassland areas on site to enhance the bluebird population. In 2004, the boxes were monitored approximately every three weeks during the breeding season to determine use and nesting success. Nineteen bluebird nests were observed. Other birds using the houses included house wrens (*Troglodytes aedon*), black-capped chickadees (*Poecile atricapilla*), and tree swallows (*Tachycineta bicolor*). Bluebirds have consistently produced 19 broods each year for the past 5 years.

6.1.3 Population Management

BNL also monitors and manages other populations, including species of interest, to ensure that they are sustained and to control invasive species.

6.1.3.1 Wild Turkey

The forested areas of BNL provide good nesting and foraging habitat for wild turkey (*Meleagris gallapavo*). The on-site population was estimated at 60 to 80 birds in 1999 and had grown to approximately 250 birds by the end of 2001. Due to drought, the population dropped to around 175 birds by the end of 2002. Conditions greatly improved in 2003, and the population was estimated at over 300 birds. Reproduction in 2004 was also successful, and the population at the end of 2004 was estimated to be approximately 500 birds.

In 2004, NYSDEC again requested authorization from BNL to trap and release wild turkey from BNL to other locations on Long Island. In March 2004, twenty-nine turkeys were trapped at BNL and released in the Easthampton area. BNL will continue to monitor the turkey population and cooperate with NYSDEC to ensure the turkeys' success at BNL and at other sites on Long Island.

6.1.3.2 White-Tailed Deer

BNL consistently updates information on the resident population of white-tailed deer (*Odocoileus virginianus*). As there are no natural predators on site and hunting is not permitted at BNL, there are no significant pressures on the population to migrate beyond their typical home range of approximately 1 square mile. A 1992 study indicated that the population of deer on site exceeded 700, or approximately 85 per square mile (Thomlinson 1993). Normally, a population density of 10 to 30 per square mile is considered an optimum sustainable level for a given area. This would equate to approximately 80 to 250 deer inhabiting the BNL property, under normal circumstances. This was the approximate density in 1966, when the Laboratory reported an estimate of 267 deer on site (Dwyer 1966). BNL has been conducting population surveys of the white-tailed deer since 2000, with

population estimates ranging from more than 1,900 deer in spring 2001 to a low of 838 during the winter of 2001/2002. In February and March 2004, an aerial infrared survey was conducted of three properties, including Wertheim National Wildlife Refuge (south of BNL), Brookhaven National Laboratory, and Rocky Point Wildlife Area (northwest of BNL). The results indicated a population of 412 deer on site and immediately off site. When a correction for survey accuracy was applied, the on-site population was estimated at 446 animals. This value was much lower than an estimate of 1,302 made at the same time using the existing ground based survey methodology. Because there was a large discrepancy between methods, a review of the ground-based methodology was conducted and the method of estimating was refined. The refined method utilizes the Laboratory's vegetation map and estimates the deer population based on the habitat in which deer are sighted during surveys. The result of this revised method indicated that the deer population was approximately 497, which is considered to be reasonably comparable to the aerial survey results. The next step taken was to apply the new population model to historic survey data. Most of the data resulted in much lower estimates, with ranges from approximately 1,000 deer in 2001 down to less than 500 deer during the autumn of 2004.

Deer overpopulation can affect animal and human health (e.g., animal starvation, Lyme disease from deer ticks, collision injuries—both human and animal), species diversity (songbird species reduction due to selective grazing and destruction of habitat by deer), and property values (auto damage and browsing damage to ornamental plantings). In 2004, there were 25 deer-related collisions on site, comparable to the 24 collisions documented in 2003. Deer health continues to be affected due to over browsing and lack of food. Deer damage to vegetation around buildings continues to be a problem, but varies depending on the severity of the winter and the availability of browse on the lawns. Although damage to shrubbery is not a threat to human health, it is undesirable because it may result in the need to replace shrubs, at substantial cost.

Because the high deer population is a regional problem, BNL is working on the issue with other entities. BNL is represented on a deer advisory panel for the hamlet of Lloyd Harbor. In addition, BNL environmental biologists would like to see a regional approach to deer management in place before attempting large-scale deer management on site. Options for deer management are limited, and most are controversial. A regional approach would benefit the community, land managers, and the health of the deer population.

6.1.4 Compliance Assurance and Potential Impact Assessment

The National Environmental Policy Act (NEPA) review process at BNL is key to ensuring that environmental impacts of a proposed action or activity are adequately evaluated and addressed. BNL will continue to use NEPA (or NEPA-like processes under the Comprehensive Environmental Response, Compensation and Liability Act [CERCLA]) when identifying potential environmental impacts associated with site activities—especially involving physical alterations. As appropriate, stakeholders such as EPA, NYSDEC, Suffolk County Department of Health Services (SCDHS), The Nature Conservancy, the Town of Brookhaven, the Community Advisory Council, and local environmental advocacy groups are involved in reviewing major projects that have the potential for significant environmental impacts.

6.2 UPTON ECOLOGICAL AND RESEARCH RESERVE

On November 9, 2000, then-Secretary of Energy Bill Richardson and Susan MacMahon, Acting Regional Director of Region 5 Fish & Wildlife Service, dedicated 530 acres of Laboratory property as an ecological research reserve. The property was designated by DOE as the Upton Ecological and Research Reserve (Upton Reserve) and is managed by FWS under an Interagency Agreement (DOE–FWS 2000). Additional information on the establishment of the Upton Reserve and accomplishments during 2004 can be found at <http://www.bnl.gov/esd/reserve/default.htm>. The Upton Reserve, on

the eastern boundary of BNL (see Figure 6-2), is home to a wide variety of flora and fauna. It contains wetlands and is largely within the core preservation area of the Long Island Central Pine Barrens. Based on information from the 1994–1995 biological survey of BNL, experts believe the reserve is home to more than 200 plant species and at least 162 species of mammals, birds, fish, reptiles, and amphibians (LMS 1995).

In establishing the Upton Reserve, DOE committed to provide FWS with \$1 million over a 5-year period, to manage the reserve. In 2001, the first full year of the reserve's existence, FWS hired two biologists, formally established the boundary, and posted the area. During 2002, these biologists conducted baseline biological survey work, initiated basic research, and funded educational programs in conjunction with BNL, Suffolk County Community College, and Longwood High School. In 2003, grants were awarded and research was initiated involving the Upton Reserve and Stony Brook University, Dowling College, and Rutgers University. In 2004, a contract for developing a database of all known Pine Barrens-related research was undertaken and a contract was initiated to develop plot-based monitoring of Pine Barrens communities. The database will allow better management of research needs and will help resource managers decide what future research to pursue. The plot-based monitoring protocols will be used to determine the current health of the forests on site and will allow detection of changes in the forest through repeated sampling efforts.

The Interagency Agreement that established the Upton Reserve specified the formation of a Technical Advisory Group (TAG), which includes the reserve's supervisory FWS biologist and representatives from NYSDEC, Suffolk County Parks Department, Central Pine Barrens Joint Policy and Planning Commission, DOE, BNL's Citizens Advisory Council, Brookhaven Executive Roundtable, Brookhaven Science Associates, and The Nature Conservancy. The TAG's primary responsibility has been to help develop the comprehensive NRMP for both BNL and the Upton Reserve that replaced the *Wildlife Management Plan* (Naidu 1999). The TAG also has developed criteria for soliciting

Figure 6-2. BNL Site Map Indicating the Boundary of the Upton Ecological and Research Reserve.

and reviewing proposals and awarding funds for research to be conducted within the Upton Reserve. Multiple research proposals have been approved over the past few years that have greatly improved the understanding of the ecology of the Pine Barrens.

In the spring of 2003, students from Longwood High School began investigating the gypsy moth (*Lymantria dispar*) population by monitoring gypsy moth egg mass distributions within the Upton Reserve. The gypsy moth has historically caused moderate to severe damage to oak trees, due to spring defoliation. The information gained from this study will be used to assist the U.S. Forest Service in determining potential management activities. The information is important to the Upton Reserve and BNL, due to the coupled effects of spring defoliation by the gypsy moth and late season defoliation

by the orange-striped oak moth caterpillar. This double defoliation results in tree death when it occurs year after year, and large sections of oak forest can be destroyed. This was observed in areas of the BNL site in 2003. Through coordination provided by the Upton Reserve, the U.S. Forest Service surveyed large sections of the Central Pine Barrens and created a map of the defoliation. At the time the map was produced, approximately 4,000 acres of oak forest had been defoliated within the Pine Barrens; approximately 1,600 acres are on the BNL site. An additional 1,000-acre area was estimated to have been defoliated by the time of leaf drop in early October 2003. The surveys, along with monitoring, will document the long-term effects of defoliation on forest health. In 2004, aerial surveys indicated that much of the infestation had concluded and that the affected area was no

longer effected by the defoliation, although a significant number of trees had died.

Additional FWS management activities for the Upton Reserve in 2004 included mapping vernal pools, assisting with bird and deer surveys, conducting educational and outreach activities, coordinating researcher access and training requirements, and conducting radio telemetry work on hognose snakes (*Heterodon platyrhinos*) and spotted turtles (*Clemmys guttata*), as discussed in Section 6.8.

6.3 MONITORING FLORA AND FAUNA

BNL conducts routine monitoring of flora and fauna to determine the impact of past and present Laboratory activities. Because soil contaminated with cesium-137 (Cs-137), a radioactive isotope of cesium, was used in some BNL landscaping projects in the past, traces have now been found in deer and in other animals and plants. Most radionuclide tables in this chapter list data for both potassium-40 (K-40), a naturally occurring radioisotope of potassium, and Cs-137. Because K-40 occurs naturally in the environment, it is not uncommon in flora and fauna. It is presented as a comparison to Cs-137 because Cs-137 competes with potassium at a cellular level. General trends indicate that Cs-137 will out-compete potassium when potassium salts are limited in the environment, which is the typical case on Long Island. In general, K-40 values do not receive significant discussion in the scientific literature due to this relationship and the fact that K-40 occurs naturally. The results of the annual sampling conducted under the flora and fauna monitoring program follow.

6.3.1 Deer Sampling

White-tailed deer in New York State typically are large, with males weighing, on average, approximately 150 pounds; females typically weigh one-third less, about 100 pounds. However, white-tailed deer on Long Island tend to be much smaller, weighing an average of 80 pounds. The available meat on local deer ranges from 20 to 40 pounds per deer. This fact has implications for calculating the potential radiation dose to consumers of deer meat containing

Cs-137, because smaller deer do not provide sufficient amounts of venison to support the necessary calculations.

In 2004, as in recent years, an off-site deer-sampling program was conducted with the NYSDEC Wildlife Branch and FWS. While most off-site samples are from road-killed deer at and near BNL, NYSDEC provides additional samples that result in data on deer that move beyond BNL boundaries, where they can be legally hunted, and also provides control data on deer living 1 mile or more from BNL. Also, FWS informs BNL staff of deer that have died in or near the Wertheim National Wildlife Refuge and other FWS properties on Long Island. In all, 25 deer were obtained on site and 18 from off-site locations, ranging from adjacent to BNL along the William Floyd Parkway, to as far away as East Islip, New York.

BNL sampling technicians collect the samples and process them for analysis. A sample of meat, liver, and bone is taken from each deer, when possible. The meat and liver are analyzed for Cs-137, and the bone is analyzed for strontium-90 (Sr-90).

6.3.1.1 Cs-137 in White-Tailed Deer

It has been previously established (BNL 2000) that white-tailed deer sampled on the BNL site contain higher concentrations of Cs-137 than deer 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. Cs-137 in soil can be transferred to aboveground plant matter via root uptake, where it then becomes available to browsing animals.

Removal of contaminated soil areas at BNL has occurred under the Laboratory's Environmental Restoration (ER) Program. All major areas of contaminated lawn soil were remediated in 2000. Some soil contamination is still present in areas that are part of Operable Units (OU) I/VI and V (operable units are explained in Chapter 2). The cleanup of areas covered by the *Record of Decision for Operable Unit I and Radiologically Contaminated Soils* (BNL 1999) will be completed as funds are

available. Cleanup of one of the two remaining contaminated soil areas under the OU I/VI actions was completed in 2002. A *Record of Decision for the Sewage Treatment Plant*, a part of OU V, was signed in 2001; cleanup there began in 2002 and was completed in 2003. All buildings at the former Hazardous Waste Management Facility were removed in 2003, and the cleanup of the remainder of the facility began in 2004 with completion scheduled for mid 2005.

The number of deer used for sampling has steadily increased since 1996. In 1998, a statistical analysis based on existing data suggested that 40 deer from off site and 25 deer from on site were needed to achieve a statistically sound data set. Since that analysis was completed, BNL has attempted to obtain the required number of deer. The number sampled each year has varied because the sampling method depends on vehicle/deer accidents and people reporting dead deer. The number of deer hit by cars can vary widely from year to year, depending on the population of deer present near major roadways. Figure 6-3 shows the location of all deer samples taken within a 5-mile radius of BNL since 2000. Most of the off-site samples are concentrated along the William Floyd Parkway on the western boundary of BNL, whereas the concentration on site is near the front gate area and the constructed portions of BNL. This distribution occurs because people on their way to work see and report dead deer. Vehicle collisions with deer on site occur primarily early or late in the day, when deer are more active.

In 2004, Cs-137 concentrations in deer meat samples taken at BNL ranged from 0.01 to 2.93 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. Dry weight concentrations are higher than wet weight values. The maximum 2004 on-site concentration (2.93 pCi/g wet weight) is much lower than the highest level reported in 2003 (5.57 pCi/g wet weight), and is significantly lower than the highest level ever reported (11.74 pCi/g wet weight, in 1996). The arithmetic average concentration in on-site meat samples was 0.68 pCi/g wet weight. The average concentra-

tion of all off-site meat samples was 0.65 pCi/g wet weight. Averages for Cs-137 both on and off site were below 1.0 pCi/g wet weight for the first time since the cleanup of landscape soils was completed in 2000.

Cs-137 concentrations in off-site deer meat samples were separated into two groups: samples taken within 1 mile of BNL and samples taken farther away (see Table 6-2). Concentrations in meat samples taken within 1 mile ranged from 0.04 to 2.75 pCi/g wet weight, with an average of 0.92 pCi/g wet weight; concentrations in meat taken from greater than 1 mile ranged from nondetectable to 1.01 pCi/g wet weight, with an average of 0.23 pCi/g wet weight.

Figure 6-4 compares the average values of Cs-137 concentrations in meat samples collected in 2004 from four different location groupings. Although the figure does not show this, more than 70 percent of all samples taken both on and off site are below 1 pCi/g wet weight (see Table 6-2).

Figure 6-5 presents the 5-year trend of on-site and near off-site Cs-137 averages in deer meat. Although there is no statistical difference between the values across the 5 years, there is a statistical difference between values in 2000 (when landscape soils were cleaned up) and values in 2002 and 2004.

In 2003, a seasonal pattern in Cs-137 concentrations in deer meat was noticed. This seasonality was present in earlier years and occurred again in 2004 (see Table 6-2). During the summer of 2004, a student in the Community College Intern program reviewed all data from 2000–2003, analyzed it statistically, and determined that there was a statistical seasonal variation in values for deer both on site as well as far off site (Florendo 2004). This seasonality is likely due to diet and the biological processing of Cs-137. From January through May, deer have a limited food supply—mostly dry vegetation from the previous year’s growth (with a fixed concentration of Cs-137 because the plants are dormant), whereas in summer and fall, deer eat more and the vegetation is constantly growing, taking up nutrients—and contaminants—from the soil. In summer and fall, if the deer

Figure 6-3. Distribution of Deer Samples, 2000–2004.

CHAPTER 6: NATURAL AND CULTURAL RESOURCES

Table 6-2. Radiological Analyses of Deer Tissue (Flesh, Liver, Bone).

Sample Location	Collection Date	Tissue Type	K-40 pCi/g Wet Weight	Cs-137 pCi/g Wet Weight	Sr-90 pCi/g Dry Weight
BNL, On Site					
Bldg. 515, loading dock east	01/06/04	Flesh	3.32 ± 0.33	0.05 ± 0.01	
		Liver	2.66 ± 0.41	0.05 ± 0.02	
		Bone			2.33 ± 0.67
Princeton Ave., just east of main gate	01/26/04	Flesh	3.60 ± 0.33	0.18 ± 0.02	
		Liver*	2.25 ± 0.22	0.04 ± 0.01	
		Bone			2.64 ± 0.50
Bldg. 490, Radiation Facility	02/02/04	Flesh	3.45 ± 0.29	0.07 ± 0.01	
		Liver*	2.28 ± 0.26	0.02 ± 0.01	
		Bone**			1.97 ± 0.44
Inner RHIC Rd. by Bldg. 1005	02/04/04	Liver	2.73 ± 0.42	ND	
		Bone			3.16 ± 0.72
Main gate at guard booth	02/12/04	Flesh	2.65 ± 0.22	0.04 ± 0.01	
		Bone			5.40 ± 0.63
South of the weather tower	02/23/04	Flesh*	3.47 ± 0.28	0.03 ± 0.01	
		Liver	2.63 ± 0.27	ND	
		Bone**			1.73 ± 0.59
South side of Brookhaven Ave., across from Berkner Hall	02/28/04	Flesh	3.51 ± 0.33	0.06 ± 0.01	
		Liver*	2.20 ± 0.20	0.03 ± 0.01	
		Bone			2.61 ± 0.50
Brookhaven Ave., east of the NSLS	03/05/04	Flesh*	2.73 ± 0.22	0.02 ± 0.00	
		Bone			ND
Princeton Ave., east of Main Gate	03/09/04	Flesh*	3.58 ± 0.29	0.04 ± 0.01	
		Bone			1.13 ± 0.28
Princeton Ave., 75 yards east of Main Gate	03/10/04	Flesh*	3.55 ± 0.32	0.11 ± 0.01	
		Liver*	2.34 ± 0.24	0.04 ± 0.01	
		Bone			1.85 ± 0.29
Inner RHIC Rd., Bldg. 1002	03/17/04	Liver	1.63 ± 0.35	ND	
Upton Gas Station	03/23/04	Flesh*	2.86 ± 0.25	0.01 ± 0.00	
		Liver	2.06 ± 0.44	ND	
		Bone			1.51 ± 0.32
Princeton Ave., 200 yards east of guard booth	04/01/04	Flesh*	3.12 ± 0.34	0.06 ± 0.01	
		Liver*	1.93 ± 0.54	0.04 ± 0.03	
		Bone			5.99 ± 0.58
Bldg. 211	04/28/04	Flesh*	4.00 ± 0.25	0.02 ± 0.01	
Bldg. 480, across from HFBR	05/25/04	Flesh*	3.22 ± 0.26	0.02 ± 0.01	
		Liver	2.72 ± 0.34	ND	
		Bone			1.69 ± 0.39
W. Princeton Ave., across from Bldg. 423	09/02/04	Flesh*	3.13 ± 0.46	0.13 ± 0.03	
		Liver*	3.07 ± 0.49	0.11 ± 0.02	
		Bone**			0.97 ± 0.32
Vehicle Monitor	09/10/04	Flesh	3.78 ± 0.30	0.33 ± 0.04	
		Bone			2.84 ± 0.58

(continued on next page)

Table 6-2. Radiological Analyses of Deer Tissue (Flesh, Liver, Bone) *(continued)*.

Sample Location	Collection Date	Tissue Type	K-40 pCi/g Wet Weight	Cs-137 pCi/g Wet Weight	Sr-90 pCi/g Dry Weight
Brookhaven Ave. and Rochester Ave.	10/07/04	Flesh*	3.54 ± 0.27	0.06 ± 0.01	
		Liver*	2.36 ± 0.13	0.03 ± 0.00	
		Bone**			0.46 ± 0.21
RHIC outer road, 1008 B	10/18/04	Flesh	3.69 ± 0.31	1.60 ± 0.15	
		Liver	3.05 ± 0.26	0.58 ± 0.06	
		Bone			1.09 ± 0.28
Brookhaven Ave. and Upton Rd.	11/09/04	Flesh	4.00 ± 0.32	2.41 ± 0.25	
		Liver	2.17 ± 0.24	1.33 ± 0.12	
		Bone			2.56 ± 0.26
Yale Rd. and York Lane	11/16/04	Flesh	4.14 ± 0.31	2.02 ± 0.21	
		Liver	4.30 ± 0.45	0.30 ± 0.03	
		Bone			1.38 ± 0.26
Bldg 1008, on top of the berm	11/18/04	Flesh	2.70 ± 0.29	0.43 ± 0.04	
		Liver*	1.07 ± 0.17	0.08 ± 0.01	
		Bone			1.42 ± 0.32
Princeton Ave., 200 ft east of Main Gate guard booth	12/02/04	Flesh	4.01 ± 0.33	2.93 ± 0.31	
		Liver	2.68 ± 0.23	0.39 ± 0.04	
		Bone**			0.61 ± 0.12
Princeton Ave., inbound lane next to Upton Gas Station	12/13/04	Flesh	3.51 ± 0.30	2.87 ± 0.20	
		Liver	1.50 ± 0.18	0.40 ± 0.03	
		Bone			1.30 ± 0.54
Bldg. 412, eastbound W. Princeton Ave.	12/15/04	Flesh	3.82 ± 0.28	2.15 ± 0.18	
		Liver	2.90 ± 0.23	0.47 ± 0.05	
		Bone			1.17 ± 0.40
< 1 Mile from BNL					
William Floyd Pkwy., north of Colonial Pines	01/22/04	Flesh	3.20 ± 0.36	0.04 ± 0.01	
		Bone			2.47 ± 0.61
William Floyd Pkwy. northbound, 1/4 mile north of Whispering Pines	01/30/04	Flesh	3.73 ± 0.30	0.16 ± 0.01	
		Liver*	3.04 ± 0.30	0.03 ± 0.01	
		Bone			4.35 ± 0.69
William Floyd Pkwy., northbound 1/4 mile north of Whispering Pines	03/23/04	Flesh*	3.19 ± 0.35	0.08 ± 0.01	
		Liver	2.08 ± 0.44	ND	
		Bone			4.81 ± 0.46
William Floyd Pkwy., 1/4 mile north of main entrance	05/12/04	Flesh	3.43 ± 0.35	0.21 ± 0.03	
		Liver*	2.78 ± 0.35	0.14 ± 0.02	
		Bone			4.29 ± 0.48
William Floyd Pkwy., 1/4 mile south of main entrance	06/24/04	Flesh*	3.76 ± 0.39	0.11 ± 0.02	
		Bone			3.50 ± 0.56
Long Island Expressway, service road, exit 68 at south gate	10/08/04	Flesh	3.97 ± 0.32	0.48 ± 0.03	
		Liver	2.75 ± 0.15	0.25 ± 0.01	
		Bone			2.26 ± 0.41

(continued on next page)

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Table 6-2. Radiological Analyses of Deer Tissue (Flesh, Liver, Bone) *(continued)*.

Sample Location	Collection Date	Tissue Type	K-40 pCi/g Wet Weight	Cs-137 pCi/g Wet Weight	Sr-90 pCi/g Dry Weight
William Floyd Pkwy. at north gate	10/14/04	Flesh	3.71 ± 0.17	2.75 ± 0.03	
		Liver	1.68 ± 0.15	0.86 ± 0.02	
		Bone		0.34 ± 0.03	1.20 ± 0.23
William Floyd Pkwy., north of Long Island Expressway	10/22/04	Flesh	3.51 ± 0.29		
		Liver*	2.92 ± 0.25	0.09 ± 0.01	
		Bone			3.67 ± 0.48
Rt. 25, east of William Floyd Pkwy.	10/26/04	Flesh	3.61 ± 0.30	1.76 ± 0.12	
		Liver	2.64 ± 0.16	0.99 ± 0.02	
		Bone	3.78 ± 0.36		5.00 ± 0.53
William Floyd Pkwy. at Colonial Pines	11/17/04	Flesh		1.86 ± 0.19	
		Liver	3.40 ± 0.25	0.80 ± 0.07	
		Bone**			0.94 ± 0.21
William Floyd Pkwy. northbound, across from SCWA wells	12/06/04	Flesh	3.89 ± 0.26	2.33 ± 0.23	
> 1 mile from BNL					
Montauk Hwy. in East Moriches	01/22/04	Flesh	3.46 ± 0.35	0.01 ± 0.01	
		Liver	2.58 ± 0.39	ND	
		Bone			3.48 ± 0.67
Old Stump Rd., Yaphank, south of railroad tracks	02/19/04	Flesh	3.99 ± 0.35	0.46 ± 0.05	
		Liver	1.77 ± 0.19	0.06 ± 0.01	
		Bone			2.73 ± 0.45
Rte. 27 Sunrise Hwy., east of Rte. 111 exit	03/16/04	Flesh	2.89 ± 0.34	1.01 ± 0.11	
Rocky Point Rd., north of Whiskey Rd.	04/17/04	Flesh*	3.57 ± 0.32	0.03 ± 0.01	
		Liver*	2.52 ± 0.23	0.01 ± 0.01	
		Bone			3.46 ± 0.47
Bartlett and Rte. 25	06/10/04	Flesh*	3.20 ± 0.30	0.05 ± 0.02	
		Liver	2.96 ± 0.25	ND	
		Bone			1.21 ± 0.24
Corner of Sound Ave. and Fresh Pond Rd.	10/01/04	Flesh	2.51 ± 0.03	ND	
		Liver	4.04 ± 0.52	ND	
		Bone			2.61 ± 0.45
30 ft east of Sound Ave. and Fresh Pond Rd.	10/01/04	Flesh*	4.02 ± 0.48	0.06 ± 0.02	
		Liver*	3.77 ± 0.55	0.0 ± 0.02	
		Bone			1.82 ± 0.35
Averages by Tissue					
Flesh					
Average for all samples			3.5 ± 2.0	0.7 ± 0.7	
BNL on-site average			3.5 ± 1.4	0.7 ± 0.5	
BNL on- and off-site < 1 mile average			3.5 ± 1.8	0.8 ± 0.6	
Off-site average			3.5 ± 1.4	0.7 ± 0.4	
Off-site < 1 mile average			3.6 ± 1.1	0.9 ± 0.3	
Off-site > 1 mile average			3.4 ± 0.9	0.2 ± 0.1	

(continued on next page)

Table 6-2. Radiological Analyses of Deer Tissue (Flesh, Liver, Bone) *(concluded)*.

Sample Location	Collection Date	Tissue Type	K-40 pCi/g Wet Weight	Cs-137 pCi/g Wet Weight	Sr-90 pCi/g Dry Weight
Liver					
Average for all samples			2.6 ± 1.9	0.2 ± 0.2	
BNL on-site average			2.4 ± 1.4	0.2 ± 0.2	
BNL on- and off-site < 1 mile average			2.5 ± 1.6	0.3 ± 0.2	
Off-site average			2.8 ± 1.2	0.2 ± 0.1	
Off-site < 1 mile average			2.7 ± 0.8	0.4 ± 0.1	
Off-site > 1 mile average			2.9 ± 0.9	0.0 ± 0.0	
Bone					
Average for all samples					2.4 ± 2.9
BNL on-site average					2.0 ± 2.1
BNL on- and off-site < 1 mile avg.					2.4 ± 2.6
Off-site average					3.0 ± 1.9
Off-site < 1 mile average					3.2 ± 1.5
Off-site > 1 mile average					2.6 ± 1.1
Notes: All values are presented with a 95% confidence interval. Potassium-40 (K-40) occurs naturally in the environment and is presented as a comparison to Cs-137. All averages are the arithmetic average and utilize estimated values for ND. Confidence limits are 2σ (95%) propagated error. HFBR = High Flux Beam Reactor ND = Not Detected					
NSLS = National Synchrotron Light Source RHIC = Relativistic Heavy Ion Collider SCWA = Suffolk County Water Authority * The cesium-137 (Cs-137) concentration was reported as an estimated value by the analytical laboratory. ** The strontium-90 (Sr-90) concentration was reported as an estimated value by the analytical laboratory.					

feed on vegetation growing in soil containing Cs-137, they are then likely to obtain a continuous supply, which is incorporated in their tissues. By January or February, the Cs-137 in their tissues has been eliminated through biological processes. The levels of Cs-137 in deer tissue during June through early August are not well known, as there are few vehicle–deer accidents at this time of year.

When possible, liver samples are taken concurrently with meat samples. Liver generally accumulates Cs-137 at a lower rate than muscle tissue (meat). The lower values in liver allow the results to be used somewhat as a validity check for meat values (i.e., if liver values are higher than meat values, results can be considered questionable and should be confirmed). In liver samples collected on site in 2004, the range of Cs-137 concentration was from nondetectable to 1.33 pCi/g wet weight, with an average of 0.20 pCi/g wet weight. The off-site Cs-137 concentration in liver ranged

from nondetectable to 0.99 pCi/g wet weight, with an average for all off-site liver samples being 0.2 pCi/g wet weight.

The potential radiological dose resulting from deer meat consumption is discussed in Chapter 8. Although hunting is restricted on site, the New York State Department of Health (NYSDOH) has formally considered the potential public health risk associated with elevated Cs-137 levels in on-site deer and has determined that no formal health advisories are warranted (NYSDOH 1999). This report can be accessed at http://www.bnl.gov/esd/wildlife/deer_issues.htm.

With respect to the health of the on-site deer based on their exposure to radionuclides, the International Atomic Energy Agency (IAEA) has concluded that chronic dose rates of 100 millirad per day to even the most radiosensitive species in terrestrial ecosystems are unlikely to cause detrimental effects in animal populations (IAEA 1992). A deer contain-

Figure 6-4. Comparison of Cs-137 Average Concentrations in Deer, 2004.

Figure 6-5. Five-Year Cs-137 Concentration Trends in Deer Meat at BNL and Within 1 Mile of BNL, 2000 to 2004.

ing a uniform distribution of Cs-137 within muscle tissue at the highest levels observed to date (11.74 pCi/g wet weight, reported in 1996) would carry a total body burden (total amount in body) of about 0.2 μ Ci. Under these conditions, an animal would receive an absorbed dose of approximately 3 millirad per day, which is only 3 percent of the threshold evaluated by the IAEA. The deer observed and sampled on site appear to have no health effects from the level of Cs-137 found in their tissues, although the general health of the herd is not optimal because of overpopulation.

6.3.1.2 *Strontium-90 in Deer Bone*

BNL began testing deer bones for Sr-90 content in 2000. In 2004, Sr-90 content in deer bone ranged from nondetectable to 5.99 pCi/g dry weight in on-site samples. Sr-90 in off-site samples ranged from 0.94 to 5.00 pCi/g dry weight in samples taken within 1 mile of BNL, and 1.21 to 3.48 pCi/g dry weight in samples taken from locations greater than a mile from BNL. This overlap in values between all samples suggests that Sr-90 is present in the environment at background levels, probably as a result of worldwide fallout from historic nuclear weapons testing. Sr-90 is present at very low levels in the environment, is readily incorporated into bone tissue, and may concentrate over time. BNL will continue to test for Sr-90 in bone to develop baseline information on this radionuclide and its presence in white-tailed deer.

6.3.2 **Small Mammal Sampling**

BNL continued small mammal sampling in 2004. The original idea for this sampling was to determine the suitability of using small mammals, primarily squirrels, as a surrogate for deer sampling. Squirrels are readily trapped and tend to eat similar food as deer, but have a much more restricted range and therefore can indicate areas where low levels of contamination may be present. Squirrels were sent to an off-site analytical laboratory for dissection and analysis. The meat was separated from the bone and tested for gamma-emitting radionuclides and the bone was tested for Sr-90.

Results of the analyses are presented in Table 6-3. Cs-137 in off-site samples ranged from nondetectable to 1.70 pCi/g dry weight. On-site samples contained Cs-137 ranging from 0.33 to 12.40 pCi/g dry weight. Sr-90 values ranged from nondetectable to 0.21 pCi/g dry weight in off-site squirrels. On-site squirrels had Sr-90 values ranging from nondetectable to 0.86 pCi/g dry weight. Small mammals will continue to be sampled to obtain additional information about their usefulness in environmental surveillance.

6.3.3 **Other Animals Sampled**

Occasionally, other animals of interest are found dead along the roads of BNL and the immediate vicinity. Wild turkey is prevalent at BNL and has a mixed diet, eating mostly insects in the spring and summer and acorns during the fall and winter. In 2004, two turkeys were hit by cars at BNL and one was hit by a car along the William Floyd Parkway. The on-site turkeys had Cs-137 concentrations of 0.01 and 0.04 pCi/g wet weight. This is comparable to the 0.04 pCi/g wet weight value seen in a turkey sampled on site in 2002. The turkey from off site had a Cs-137 concentration of 0.11 pCi/g wet weight.

Two Canada geese hit by cars on site were sampled during 2004. Geese typically graze on the lawns around the Laboratory, but are less selective in feeding compared to deer. Cs-137 was found in concentrations between nondetectable and 0.02 pCi/g wet weight. This is comparable to the far off-site values found in deer meat and suggests that Canada geese do not have significant uptake of Cs-137.

Sr-90 in bone taken from the on-site turkeys was nondetectable in one and 0.46 pCi/g dry weight in the other. The off-site turkey had a Sr-90 value of 0.77 pCi/g dry weight. The two geese taken on site had Sr-90 values of 0.47 and 0.77 pCi/g. Sr-90 values in turkey and geese are comparable to values seen in squirrels on site.

6.3.4 **Fish Sampling**

In collaboration with the NYSDEC Fisheries Division, BNL maintains an ongoing pro-

Table 6-3. Radiological Analyses of Small Mammals (Squirrels), Turkeys, and Geese.

Location	Collection Date	Species	K-40	Cs-137	Sr-90
				pCi/g, Dry Weight ³	
BNL					
Trailer-533	04/09/04	Squirrel	13.1 ± 2.8	1.55 ± 0.28	ND
Trailer-533	08/18/04	Squirrel ¹	14.6 ± 1.9	5.68 ± 0.46	0.62 ± 0.26
Trailer-533	09/14/04	Squirrel ¹	11.5 ± 1.3	3.51 ± 0.27	0.69 ± 0.24
Upton St. and Bell Ave.	04/22/04	Squirrel	13.4 ± 3.8	0.33 ± 0.26	0.32 ± 0.33
Upton St. and Bell Ave.	08/20/04	Squirrel ¹	12.4 ± 1.5	7.26 ± 0.55	0.85 ± 0.23
Bldg. 569	09/17/04	Squirrel	11.2 ± 1.3	7.41 ± 0.55	ND
Bldg. 569	10/15/04	Squirrel ¹	11.9 ± 1.4	12.40 ± 0.97	0.86 ± 0.20
BERA Softball Fields	03/04/04	Turkey ^{2,3}	3.5 ± 0.3	0.04 ± 0.01	ND
Lawrence Ave. and Rutherford St.	05/10/04	Turkey ^{1,2,3}	3.7 ± 0.5	0.01 ± 0.01	0.46 ± 0.14
East of Bldg. 488	04/13/04	Goose ^{1,3}	3.8 ± 0.3	ND	0.77 ± 0.19
Bldg. 479	05/26/04	Goose ^{1,2,3}	3.9 ± 0.3	0.02 ± 0.02	0.47 ± 0.18
Off Site					
Mastic Beach	03/02/04	Squirrel	13.2 ± 2.7	ND	ND
Flanders	09/03/04	Squirrel ¹	8.6 ± 1.3	1.70 ± 0.19	0.21 ± 0.10
William Floyd Parkway	09/10/04	Turkey ^{1,2,3}	2.7 ± 0.3	0.11 ± 0.02	0.77 ± 0.27

Notes:

All values are presented with a 95% confidence interval.

Potassium-40 (K-40) occurs naturally in the environment and is presented as a comparison to Cs-137.

¹ = The cesium-137 (Cs-137) concentration was reported as an estimated value by the analytical laboratory.

² = The strontium-90 (Sr-90) concentration was reported as an estimated value by the analytical laboratory.

³ = Cs-137 values for turkeys and geese are presented as pCi/g wet weight.

ND = Not Detected

gram for collecting and analyzing fish from the Peconic River and surrounding freshwater bodies. The annual sampling at BNL over the past several years has depleted the number of larger fish. As a result, it would be necessary to take more of the smaller fish to obtain a sufficiently large sample to complete all analyses desired. For this reason, BNL suspended most on-site sampling beginning in 2001. Population surveys over the past three years indicate that population levels on site are still insufficient to conduct full-scale annual sampling and analysis. However, in 2004, the Peconic River cleanup project began with dewatering of the on-site portion of the river as an early step. This provided an opportunity to collect several composite samples of chain pickerel and pumpkinseed. After the cleanup project is completed, the suspension of on-site fish sampling will resume until fish populations have recovered.

Off-site fish sampling continued as in the past. All samples were analyzed for whole-body content of each of the analytes reported; in most instances, the samples were a composite of several fish to ensure adequate sample size for analysis. In 2004, various species of fish were collected off site from Swan Pond, Donahue's Pond, Forge Pond, and Lower Lake on the Carmans River (see Figure 5-8 for sampling stations). Swan Pond is a semi-control location on the Peconic River system (a tributary of the Peconic not connected to the BNL branch) and Lower Lake on the Carmans River is the non-Peconic control site. As part of pre-cleanup operations, several fish from Donahue's Pond were sampled and analyzed for mercury. Analyses of these fish were conducted on edible portions only (fillets). Sampling is carried out in cooperation with NYSDEC and through a contract with Cold Spring Harbor Fish Hatchery and

Museum. Seventy-two samples were taken, representing seven species of fish.

6.3.4.1 Radiological Analysis of Fish

The species collected for radiological analyses in 2004 by BNL and through contract labor included brown bullhead (*Ictalurus nebulosus*), chain pickerel (*Esox niger*), largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), golden shiner (*Notemigonus crysoleucas*), and yellow perch (*Perca flavescens*). Gamma spectroscopy analysis was performed on all samples. Table 6-4 presents specific information on the sampling location, species collected, and analytical results. All sample results are presented as dry weight concentrations.

Cs-137 was detected at low levels in all samples from the Peconic River system, ranging from 0.08 pCi/g dry weight in chain pickerel from Donahue's Pond, to 1.05 pCi/g dry weight in pumpkinseed from BNL. In 2004, fish taken from Lower Lake on the Carmans River (the non-Peconic control location) showed estimated levels of Cs-137 ranging from below the minimum detection limit (MDL) in largemouth bass to 0.20 pCi/g dry weight in golden shiners.

Sr-90 is readily deposited in bone. In 2004, BNL continued the testing for Sr-90 that was initiated in 2000. Values ranged from nondetectable to 1.58 pCi/g dry weight. Because fish were analyzed for whole-body content, values for Sr-90 may vary somewhat, as seen in the data presented in Table 6-4. These variations result from random pieces of bone included in the portion of the sample used for analysis. BNL will continue to test for Sr-90 in off-site samples in order to build baseline values for future comparisons.

Some Cs-137 is detectable in the environment worldwide as a result of global fallout from past aboveground nuclear weapons testing. This is evident when examining the analytical results of fish from the control locations. To account for the different feeding habits and weights of various species, it is important to compare species with similar feeding habits (i.e., bottom feeders such as brown bullhead should be compared to other bottom feed-

ers—in this case, other brown bullhead). Cs-137 concentrations in bullhead collected at all locations along the Peconic River had values less than 0.80 pCi/g dry weight, whereas values for bullhead at Lower Lake on the Carmans River had 0.07 pCi/g dry weight. Comparison of pumpkinseed shows levels of Cs-137 on site to be 1.05 pCi/g dry weight compared to 0.08 pCi/g dry weight in fish from Lower Lake on the Carmans River. Levels of Cs-137 in all fish species appear to be declining, compared with historic values.

Though it is clear from discharge records and sediment sampling that past BNL operations have contributed to anthropogenic (human-caused) radionuclide levels in the Peconic River system, most of these radionuclides—with the exception of tritium—were released between the late 1950s and early 1970s. Concentrations continue to decline over time through natural decay and remedial activities. Cs-137 has a half-life of 30 years. No Cs-137 was released from the STP to the Peconic River in 2003 or 2004 (see Figure 5-5 for a trend of Cs-137 discharges). Additionally, the cleanup of both on-site and off-site portions of the river in 2004 removed small quantities of Cs-137 in the sediment that was co-located with mercury. Removal of this contamination should result in further decreases in Cs-137 levels in fish.

6.3.4.2 Fish Population Assessment

As mentioned above, BNL suspended fish sampling on site in 2001 because prior fish sampling had depleted the population and limited the remaining fish to smaller sizes. Because the cleanup of the Peconic River was initiated in April 2004, a population assessment was not conducted. However, a number of fish were retrieved and moved to suitable portions of the river in order for them to survive. These rescued fish included 218 brown bullhead, 193 banded sunfish (mentioned previously), 34 pumpkinseed, 32 chain pickerel, 4 creek chubsuckers, 3 golden shiners, and 15 unidentified minnows. These numbers are comparable to the numbers seen in previous years and continue to reflect lack of fish large enough to warrant sampling.

Table 6-4. Radiological Analyses of Fish from the Peconic River System and Carmans River, Lower Lake Control Location.

	K-40	Cs-137	Sr-90		K-40	Cs-137	Sr-90
		pCi/g, Dry Weight				pCi/g, Dry Weight	
BNL, On Site				Donahue's Pond (<i>continued</i>)			
Chain pickerel ¹	11.8 ± 1.3	0.64 ± 0.08	0.8 ± 0.4	Brown bullhead	NR	0.44 ± 0.32	NT
Chain pickerel	13.2 ± 1.8	0.55 ± 0.10	ND	Brown bullhead	NR	0.61 ± 0.16	NT
Chain pickerel ¹	11.2 ± 1.4	0.61 ± 0.10	0.7 ± 0.3	Brown bullhead	NR	0.40 ± 0.10	NT
Pumpkinseed	11.8 ± 1.7	1.05 ± 0.15	ND	Brown bullhead	NR	0.67 ± 0.20	NT
Manor Road (HB)				Brown bullhead	NR	0.39 ± 0.13	NT
Brown bullhead ¹	9.6 ± 1.2	0.25 ± 0.05	0.7 ± 0.3	Brown bullhead	NR	0.40 ± 0.10	NT
Pumpkinseed	12.0 ± 1.4	0.33 ± 0.06	ND	Brown bullhead	NR	0.80 ± 0.16	NT
Donahue's Pond				Brown bullhead	NR	0.54 ± 0.30	NT
Chain pickerel	NR	0.17 ± 0.03	NT	Forge Pond			
Chain pickerel	NR	0.20 ± 0.03	NT	Bluegill	8.8 ± 0.8	0.22 ± 0.04	ND
Chain pickerel	NR	0.16 ± 0.03	NT	Bluegill	8.2 ± 0.8	0.18 ± 0.03	ND
Chain pickerel	NR	0.18 ± 0.04	NT	Bluegill	8.5 ± 0.9	0.21 ± 0.05	ND
Chain pickerel	NR	0.16 ± 0.05	NT	Pumpkinseed ²	9.2 ± 0.7	0.18 ± 0.04	ND
Chain pickerel	NR	0.18 ± 0.04	NT	Chain pickerel	11.1 ± 0.7	0.35 ± 0.03	ND
Chain pickerel	NR	0.16 ± 0.04	NT	Chain pickerel	10.9 ± 1.0	0.43 ± 0.05	ND
Chain pickerel	NR	0.22 ± 0.04	NT	Chain pickerel	10.1 ± 1.8	0.37 ± 0.09	ND
Chain pickerel	NR	0.17 ± 0.07	NT	Largemouth bass	10.1 ± 0.9	0.34 ± 0.05	ND
Chain pickerel	NR	0.18 ± 0.04	NT	Largemouth bass	7.7 ± 0.8	0.26 ± 0.04	ND
Chain pickerel	NR	0.12 ± 0.04	NT	Largemouth bass ¹	10.2 ± 0.9	0.44 ± 0.05	0.6 ± 0.3
Chain pickerel	NR	0.16 ± 0.04	NT	Golden shiner	9.7 ± 0.9	0.11 ± 0.03	ND
Chain pickerel	NR	0.16 ± 0.04	NT	Golden shiner ²	9.5 ± 0.9	0.12 ± 0.03	1.0 ± 0.4
Chain pickerel	NR	0.14 ± 0.04	NT	Yellow perch	10.8 ± 0.9	0.32 ± 0.04	ND
Chain pickerel	NR	0.15 ± 0.04	NT	Brown bullhead	11.4 ± 1.2	0.43 ± 0.09	ND
Chain pickerel	NR	0.10 ± 0.04	NT	Swan Pond			
Chain pickerel	NR	0.20 ± 0.07	NT	Bluegill ²	7.1 ± 1.1	0.20 ± 0.06	1.4 ± 0.4
Chain pickerel	NR	0.17 ± 0.04	NT	Bluegill ²	8.3 ± 1.0	0.17 ± 0.05	1.6 ± 0.4
Chain pickerel	NR	0.16 ± 0.05	NT	Pumpkinseed ²	9.6 ± 1.4	0.18 ± 0.12	1.0 ± 0.4
Chain pickerel	NR	0.08 ± 0.07	NT	Yellow perch ¹	9.5 ± 1.2	0.39 ± 0.06	0.5 ± 0.3
Brown bullhead	NR	0.43 ± 0.12	NT	Yellow perch ¹	8.3 ± 1.2	0.38 ± 0.07	0.8 ± 0.3
Brown bullhead	NR	0.41 ± 0.17	NT	Largemouth bass	11.2 ± 0.8	0.41 ± 0.05	1.1 ± 0.4
Brown bullhead	NR	0.61 ± 0.13	NT	Largemouth bass ¹	9.1 ± 1.7	0.41 ± 0.11	1.0 ± 0.4
Brown bullhead	NR	0.42 ± 0.15	NT	Chain pickerel	9.8 ± 1.3	0.38 ± 0.07	ND
Brown bullhead	NR	0.36 ± 0.11	NT	Lower Lake, Carmans River			
Brown bullhead	NR	0.55 ± 0.13	NT	Largemouth bass	10.7 ± 1.6	ND	ND
Brown bullhead	NR	0.57 ± 0.21	NT	Brown bullhead	12.5 ± 1.4	0.07 ± 0.04	ND
Brown bullhead	NR	0.53 ± 0.15	NT	Bluegill ^{1,2}	10.6 ± 1.2	0.06 ± 0.04	0.6 ± 0.3
Brown bullhead	NR	0.41 ± 0.11	NT	Bluegill	8.7 ± 1.2	0.08 ± 0.04	ND
Brown bullhead	NR	0.43 ± 0.11	NT	Pumpkinseed	11.5 ± 1.5	0.08 ± 0.05	ND
Brown bullhead	NR	0.64 ± 0.71	NT	Golden shiner	7.5 ± 2.2	0.20 ± 0.10	ND

Notes:

All values are presented with a 95% confidence interval.

Potassium-40 (K-40) occurs naturally in the environment and is presented as a comparison to Cs-137.

Fish taken from Donahue's Pond as part of the OU V project were tested as fillets.

Samples were not analyzed for K-40 and Sr-90.

See Figure 5-8 for sampling stations.

ND = Not Detected

NR = Not Reported by analytical laboratory

NT = Not Tested

¹ = The cesium-137 (Cs-137) concentration was reported as an estimated value for by the analytical laboratory.² = The strontium-90 (Sr-90) concentration was reported as an estimated value by the analytical laboratory.

6.3.4.3 Nonradiological Analysis of Fish

In 1997, under the OU V remediation project, the BNL ER Program sampled and analyzed fish from the Peconic River for metals, pesticides, and PCBs. The contaminant levels found were not considered by NYSDEC to have a health impact on fish or humans, but DOE directed that sampling and analyses should be done annually. This analysis was conducted on site in 1999 and 2000; analysis in 2001 and 2002 was limited to off-site fish. The timing of sampling has varied from year to year, as well as the sample preparation (whole-body, tissue separation, composite sampling). In 1997, sampling was performed during April through May; in 1999, sampling was performed during September through December. Since 2000, sampling has occurred from July through August. Additionally, there has been a wide variation in fish size; therefore, samples have had to be composite whole-body to obtain significant mass for analysis. These variables make the comparisons from year to year difficult, as there can be significant seasonal variations in feeding, energy consumption, and incorporation of nutrients in tissues.

Table 6-5 shows the concentrations of metals in fish for 2004. None of the metal concentrations were considered capable of affecting the health of the consumers of such fish, according to NYSDEC. Because the values for arsenic, beryllium, cobalt, silver, thallium, and vanadium were near or less than the MDL for the analytical procedure, they were not included in Table 6-5. Other metals tested but not included in the table include aluminum, antimony, cadmium, and silver because the majority of the values reported were less than MDL and those values that were reported were just above MDL and were not considered to be indicative of a health risk.

Mercury is a metal of concern due to its known health effects. Mercury was found in on-site fish at levels of 0.73 mg/kg or lower and 0.68 mg/kg or lower in off-site fish from the Peconic River. Both values are less than the 1.0 mg/kg consumption standard set by the U.S. Food and Drug Administration.

Table 6-6 shows the concentrations of DDT

and its breakdown products that were found in low levels in both on- and off-site fish sampled in 2004. In addition to those pesticides shown in Table 6-6, the pesticide Aldrin was found in a single bluegill at 0.011 mg/kg; Chlordane was found in two yellow perch from Forge Pond at levels of 0.037 and 0.204 mg/kg and in a pumpkinseed taken from Lower Lake on the Carmans River at 0.032 mg/kg; and Dieldrin was detected in a composite sample of pumpkinseed taken on site at BNL at 0.021 mg/kg. These levels of pesticides detected do not exceed any standards that may constitute a health impact to the consumers of such fish and thus are not considered harmful. DDT was commonly used on Long Island before 1970. Chlordane was also commonly used across Long Island and is found occasionally in fish samples. Dieldrin is a breakdown product of Aldrin, which was commonly used to treat soil insects in crops (termites in potatoes). Of the pesticides detected, only DDT and its breakdown products remain at significantly measurable levels in the environment.

PCBs were found at levels above the method detection limit in two samples taken on site at BNL and in one sample taken off site, at Swan Pond. Aroclor-1254 was found in a sample of pumpkinseed and chain pickerel taken from an area of the Peconic River located near the east firebreak on BNL. Values were 0.137 mg/kg and 0.049 mg/kg, respectively. A sample of largemouth bass taken from Swan Pond had a concentration of 0.027 mg/kg of Aroclor-1260. Historically, PCBs have been found in both fish and sediment on site at BNL and periodically at other locations in the Peconic River. The cleanup of the Peconic River (to be completed in 2005) is expected to remove the majority of PCBs within the sediments.

6.3.5 Aquatic Sampling

6.3.5.1 Radiological Analysis

Annual sampling of sediment, vegetation, and freshwater in the Peconic River and a control location on the Carmans River was conducted in 2004. (On-site portions of the Peconic River were not sampled because the river cleanup project was underway.) See Chapter 5 for a

CHAPTER 6: NATURAL AND CULTURAL RESOURCES

Table 6-5. Metals Analyses of Fish from the Peconic River System and Carmans River, Lower Lake Control Location.

	Barium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Selenium	Zinc
Location/Species					mg/kg				
BNL, On Site									
Chain pickerel	1.96	0.34	1.39	18.0	<MDL	9.22	0.39	0.54	59.9
Chain pickerel	1.19	0.22	2.44	32.8	0.331	2.48	0.23	0.53	53.6
Chain pickerel	0.25	<MDL	1.61	61.9	<MDL	0.89	0.26	1.12	109
Pumpkinseed	4.79	0.68	1.43	33.5	<MDL	2.36	0.73	0.45	26.6
Manor Road (HB)									
Brown bullhead	2.00	0.16	1.25	43.6	<MDL	2.00	0.18	0.54	14.7
Pumpkinseed	2.49	0.84	0.71	21.1	<MDL	29.60	0.30	0.25	64.4
Donahue's Pond ¹									
Chain pickerel	<MDL	<MDL	<MDL	2.0	<MDL	0.39	0.44	0.67	6.65
Chain pickerel	<MDL	<MDL	0.21	3.4	<MDL	0.27	0.51	0.71	6.72
Chain pickerel	<MDL	<MDL	0.25	4.2	<MDL	0.49	0.57	0.41	9.22
Chain pickerel	0.12	<MDL	0.30	4.4	<MDL	0.72	0.63	0.64	11.2
Chain pickerel	<MDL	<MDL	0.29	3.3	<MDL	0.27	0.53	0.50	11.6
Chain pickerel	0.07	<MDL	0.36	9.3	<MDL	0.65	0.51	0.49	19.4
Chain pickerel	<MDL	0.17	0.72	8.5	<MDL	0.18	0.44	0.72	11
Chain pickerel	<MDL	<MDL	0.25	3.0	<MDL	0.33	0.59	0.58	8.96
Chain pickerel	<MDL	<MDL	0.29	5.4	<MDL	0.18	0.36	0.46	11.4
Chain pickerel	0.25	0.18	0.33	8.0	<MDL	2.31	0.43	0.54	45.9
Chain pickerel	<MDL	<MDL	0.30	3.6	<MDL	0.15	0.36	0.59	10.4
Chain pickerel	<MDL	<MDL	0.26	2.1	<MDL	0.20	0.58	0.68	7.35
Chain pickerel	<MDL	<MDL	<MDL	3.9	<MDL	0.14	0.35	0.86	9.48
Chain pickerel	<MDL	<MDL	0.50	5.4	<MDL	0.53	0.55	0.72	20.7
Chain pickerel	<MDL	<MDL	0.28	4.6	<MDL	0.21	0.39	0.81	12.3
Chain pickerel	0.12	<MDL	0.60	13.7	<MDL	1.06	0.29	0.71	30.6
Chain pickerel	<MDL	0.20	0.34	4.2	<MDL	0.51	0.47	0.59	9.6
Chain pickerel	<MDL	0.16	0.62	5.1	<MDL	0.31	0.44	0.71	16.1
Chain pickerel	<MDL	<MDL	0.30	3.0	<MDL	0.24	0.41	0.47	12.3
Chain pickerel	<MDL	<MDL	0.41	3.9	<MDL	0.23	0.68	0.71	7.06
Brown bullhead	0.19	<MDL	0.36	14.9	<MDL	0.30	0.13	0.68	7.03
Brown bullhead	0.16	<MDL	<MDL	5.4	<MDL	0.27	0.17	0.52	5.15
Brown bullhead	0.12	<MDL	0.27	8.5	<MDL	0.27	0.18	0.42	6.76
Brown bullhead	0.17	<MDL	<MDL	11.9	<MDL	0.25	0.14	0.84	7.52
Brown bullhead	0.14	<MDL	<MDL	6.5	<MDL	0.21	0.17	0.57	3.91
Brown bullhead	0.15	0.21	<MDL	9.0	<MDL	0.18	0.34	0.76	6.07
Brown bullhead	0.19	0.16	<MDL	10.7	<MDL	0.21	0.18	0.92	7.22
Brown bullhead	0.19	0.16	<MDL	8.7	<MDL	0.22	0.20	0.58	5.6
Brown bullhead	0.22	<MDL	<MDL	8.1	<MDL	0.18	0.19	0.54	6.44
Brown bullhead	0.24	<MDL	<MDL	17.8	<MDL	0.27	0.22	0.89	6.33
Brown bullhead	0.18	<MDL	<MDL	4.6	<MDL	0.23	0.14	0.58	6.09
Brown bullhead	0.28	<MDL	<MDL	8.2	<MDL	0.37	0.17	0.85	6.55

(continued on next page)

Table 6-5. Metals Analyses of Fish from the Peconic River System and Carmans River, Lower Lake Control Location (*concluded*).

Location/Species	Barium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Selenium	Zinc
					mg/kg				
Brown bullhead	0.40	<MDL	0.23	9.3	<MDL	0.26	0.18	0.89	7.44
Brown bullhead	0.21	<MDL	<MDL	8.7	<MDL	0.25	0.14	0.75	6.81
Brown bullhead	0.18	<MDL	<MDL	8.1	<MDL	0.24	0.30	0.67	7.63
Brown bullhead	0.27	<MDL	<MDL	8.1	<MDL	0.21	0.14	0.46	6.15
Brown bullhead	0.18	0.16	0.25	8.4	<MDL	0.30	0.29	0.63	6.52
Brown bullhead	0.20	<MDL	<MDL	7.3	<MDL	0.25	0.13	0.65	6.88
Forge Pond									
Bluegill	2.55	0.37	0.80	29.7	<MDL	9.32	0.09	0.16	24.2
Bluegill	1.54	0.29	0.62	19.9	0.4	6.93	0.09	0.73	15
Bluegill	1.67	0.30	0.36	13.4	<MDL	7.50	0.24	0.16	17.7
Pumpkinseed	1.96	0.32	0.64	76.0	<MDL	14.90	0.09	0.19	22.9
Chain pickerel	<MDL	0.22	<MDL	2.7	<MDL	0.15	0.16	0.38	4.69
Chain pickerel	<MDL	<MDL	<MDL	1.8	<MDL	0.16	0.26	0.48	7.39
Chain pickerel	0.48	0.22	0.35	11.0	<MDL	4.34	0.26	0.17	45.2
Largemouth bass	<MDL	<MDL	0.35	2.5	<MDL	<MDL	0.23	0.16	4.57
Largemouth bass	0.41	0.16	0.29	38.8	<MDL	1.03	0.23	0.25	8.61
Largemouth bass	<MDL	<MDL	<MDL	2.3	<MDL	<MDL	0.12	0.16	4.8
Golden shiner	20.90	0.40	0.50	39.8	<MDL	17.60	0.07	0.37	22.5
Golden shiner	12.00	0.64	0.58	46.1	<MDL	24.20	0.10	0.34	26.7
Yellow perch	0.21	<MDL	0.49	10.7	<MDL	1.95	0.06	0.16	6.99
Brown bullhead	0.17	<MDL	0.60	10.9	<MDL	0.35	0.20	0.31	7.63
Swan Pond									
Bluegill	5.68	0.54	1.79	81.4	0.618	61.60	0.05	0.33	42.3
Bluegill	7.48	0.91	0.60	30.3	<MDL	33.00	0.07	0.74	45.6
Pumpkinseed	5.63	1.06	0.30	8.4	<MDL	25.10	0.04	0.90	34.8
Yellow perch	3.27	0.46	0.70	16.3	<MDL	48.50	0.01	0.77	23.2
Yellow perch	2.48	0.35	0.89	13.7	<MDL	28.80	0.03	0.81	18.5
Largemouth bass	1.18	0.40	0.30	12.7	<MDL	14.30	0.12	0.30	20.6
Largemouth bass	0.77	0.27	0.30	9.7	<MDL	11.20	0.12	0.38	15.8
Chain pickerel	0.18	<MDL	0.33	8.0	<MDL	6.85	0.16	0.26	41.9
Lower Lake, Carmans River									
Largemouth bass	0.10	<MDL	0.23	3.4	<MDL	0.54	0.18	0.24	6.03
Brown bullhead	0.16	<MDL	0.27	8.0	<MDL	0.41	0.04	0.16	5.21
Bluegill	0.54	<MDL	0.26	9.1	<MDL	3.67	0.08	0.86	11.7
Bluegill	2.05	0.22	0.47	18.2	0.30	8.24	0.01	0.50	18.9
Pumpkinseed	2.43	0.47	0.55	30.0	0.45	16.90	0.04	0.16	33.3
Golden shiner	15	0.19	0.54	24.7	0.43	61.30	0.03	0.16	20.4

Notes:

See Figure 5-8 for sampling locations.

MDL = Minimum Detection Limit

¹ = Fish from Donahue's Pond were analyzed as fillets; all others were analyzed whole body.

Table 6-6. Pesticide Analysis of Fish from the Peconic River System and Carmans River, Lower Lake Control Location.

	4,4'-DDD	4,4'-DDE	4,4'-DDT		4,4'-DDD	4,4'-DDE	4,4'-DDT
Location / Species	µg/kg			Location / Species	µg/kg		
BNL, On Site				Donahue's Pond¹ (continued)			
Chain pickerel	< MDL	8.7*	8.9*	Brown bullhead	3.91*	3.39*	42.2
Pumpkinseed	5.5	17.7	37.8	Brown bullhead	2.37*	3.32*	< MDL
Chain pickerel	< MDL	4.7*	9*	Brown bullhead	2.96*	2.68*	< MDL
Unknown	8.6	20.1	15.1	Brown bullhead	2.54*	2.12*	< MDL
Manor Road (HB)				Brown bullhead	2.77*	1.99*	< MDL
Brown bullhead	25.6	36.4	5.5*	Brown bullhead	2.23*	1.8*	< MDL
Pumpkinseed	10.4	41.4	11.4	Brown bullhead	< MDL	1.77*	< MDL
Donahue's Pond¹				Forge Pond			
Chain pickerel	15.7	35.8	10.5	Bluegill	9.2	19.5	4.8*
Chain pickerel	9.0	23.5	9.3	Bluegill	5.6	19.9	3.9*
Chain pickerel	16.3	45.8	11.3	Bluegill	12.1	29.7	6.1*
Chain pickerel	11.0	31.8	12.9	Pumpkinseed	7.5	27.8	5.5*
Chain pickerel	12.8	17.2	9.2	Chain pickerel	< MDL	23.7	4*
Chain pickerel	< MDL	4.6	< MDL	Chain pickerel	6.9	24.6	5.5*
Chain pickerel	6.0	13.0	9.3	Chain pickerel	< MDL	7.6*	< MDL
Chain pickerel	4.3	6.1	< MDL	Largemouth bass	10.5	42.3	6.8*
Chain pickerel	4.3	6.1	< MDL	Largemouth bass	< MDL	12.9	< MDL
Chain pickerel	12.8	34.7	10.0	Largemouth bass	9.4	40.4	6.8*
Chain pickerel	4.8	7.8	< MDL	Golden shiner	< MDL	4*	< MDL
Chain pickerel	< MDL	< MDL	< MDL	Golden shiner	6.9	8*	2.5*
Chain pickerel	< MDL	4.4	9.1	Yellow perch	82.6	230	23.8*
Chain pickerel	< MDL	4.7	< MDL	Brown bullhead	12.0	27.1	4.1*
Chain pickerel	6.5	11.2	18.9	Swan Pond			
Chain pickerel	8.2	17.3	< MDL	Bluegill	< MDL	< MDL	9.9
Chain pickerel	18.6	23.3	34.5	Bluegill	< MDL	7.2*	2.0
Chain pickerel	42.4	124	19.3	Pumpkinseed	< MDL	19.3	< MDL
Chain pickerel	4.9	6.7	< MDL	Yellow perch	6.1	21.3	0.59*
Chain pickerel	7.1	13.0	9.0	Yellow perch	35.6	130	9*
Brown bullhead	4.7	5.8	20.1	Largemouth bass	< MDL	21.4	2.6*
Brown bullhead	< MDL	4.86*	38.2	Largemouth bass	< MDL	22.1	< MDL
Brown bullhead	2.62*	6.4	10.6	Chain pickerel	< MDL	10.9	< MDL
Brown bullhead	3.06*	2.93*	< MDL	Lower Lake, Carmans River			
Brown bullhead	< MDL	1.52*	< MDL	Largemouth bass	8.9	41.2	10.1
Brown bullhead	2.7*	2.11*	< MDL	Brown bullhead	10.0	44.1	5.2*
Brown bullhead	< MDL	1.04*	< MDL	Bluegill	6.2	22.7	< MDL
Brown bullhead	3.83*	5.3	7.8	Bluegill	6.0	23.3	< MDL
Brown bullhead	< MDL	1.74*	7.2	Pumpkinseed	10.9	52.2	6.4*
Brown bullhead	4.1	7.0	9.1	Goldenshiner	10.7	38.8	< MDL
Brown bullhead	< MDL	0.78*	5.8				

Notes:

See Figure 5-8 for sampling locations.

MDL = Minimum Detection Limit

* The reported concentration was estimated by the analytical laboratory.

¹ = Fish from Donahue's Pond were analyzed as filets; all others as whole body.

discussion of water quality and monitoring, and Figure 5-8 for sampling stations. Table 6-7 summarizes the radiological data. Low levels of Cs-137 were documented in sediments at all locations, except Forge Pond. Aquatic vegetation taken from off-site locations did not have detectable levels of Cs-137.

6.3.5.2 *Metals in Aquatic Samples*

Metals analyses (Table 6-8) were conducted on aquatic vegetation and sediments from the Peconic River and Carmans River. Most of the data indicate metals at background levels. The standard used for comparison of sediments is the soil cleanup objectives for heavy metals supported by SCDHS. Vegetation results are compared to soil cleanup standards because metals in vegetation may accumulate via uptake from sediment. In general, metals are seen in vegetation at levels lower than in associated sediment.

Off site, levels of arsenic, cadmium, chromium, and nickel were higher than the SCDHS cleanup objectives in sediment at Swan Pond, and chromium was higher than the cleanup objectives at the Lower Lake on the Carmans River sampling location. No other metals were above cleanup objectives in either sediment or vegetation.

6.3.5.3 *Pesticides and PCBs in Aquatic Samples*

Pesticides and PCBs are reported in Table 6-9 for only those samples with detectable levels. Sediments from Swan Pond contained low levels of the DDT breakdown products DDE and DDD. A water sample from Swan Pond contained very low levels of DDE. Sediments taken at station HC on the Peconic River (see Figure 5-8 in Chapter 5) contained low levels of alpha-BHC, Lindane, Heptachlor, DDT, and the PCB Aroclor-1254. The water sample from station HC had detectable levels of DDT. As mentioned above, DDT was one of the pesticides used widely in the 1950s and 1960s, and residual amounts are still detected. Finally, in a vegetation sample from Lower Lake on the Carmans River, a low level of the PCB Aroclor-1254 was detected.

6.3.6 **Vegetation Sampling**

6.3.6.1 *Garden Vegetables*

On-site sampling of garden vegetables continued in 2004. Samples of zucchini, cucumber, tomato, pepper, and eggplant were analyzed for Cs-137 content. Samples of both tomatoes and peppers had a Cs-137 value of 0.01 pCi/g wet weight, and the soil sample taken concurrently from the garden had a Cs-137 value of 0.18 pCi/g dry weight. Sampling of off-site farm vegetation was discontinued in 2003 because historical data have consistently indicated the absence of BNL-related radionuclides in off-site vegetation. Periodic confirmatory sampling (approximately every 5 years) will be conducted off site to obtain data on farm vegetables.

6.3.6.2 *Grassy Plants*

In 2003, grassy vegetation sampling was converted to a graded approach and was linked to other sampling programs. As an example of this approach, vegetation sampling would be conducted only if routine air sampling indicated that radionuclides had been released and deposited on soil and vegetation. Periodic confirmatory sampling of grassy vegetation will be conducted approximately every 5 years.

6.4 **SOIL SAMPLING**

Soil sampling uses the same graded approach as that used for grassy vegetation sampling and was taken out of the basic monitoring protocols in 2003. Confirmatory soil sampling will be conducted periodically.

6.5 **BASIN SEDIMENTS**

A new 5-year testing cycle for basin sediment samples was established in 2003. There are 14 basins associated with outfalls that receive discharges permitted under the State Pollutant Discharge Elimination System (SPDES) permit (see Figure 5-6 for basin locations). The next round of basin sampling will occur in 2008.

6.6 **CHRONIC TOXICITY TESTS, SEWAGE TREATMENT PLANT**

Under the SPDES discharge permit, BNL was not required to conduct chronic toxicity testing for the STP effluent in 2004 because of

Table 6-7. Radiological Analyses of Aquatic Vegetation and Sediment from the Peconic River System and Carmans River, Lower Lake Control Location.

Location/Sample Type	K-40 —— pCi/g Dry Weight ——	Cs-137
Forge Pond		
Lily Pad	25.10 ± 9.01*	ND
Sediment	1.45 ± 0.39	ND
Swan Pond		
Lily Pad	NR	ND
Sediment	NR	0.46 ± 0.16**
HC		
Vegetation	39.30 ± 6.43*	ND
Sediment	1.75 ± 0.22	0.03 ± 0.01**
Lower Lake, Carmans River		
Vegetation	1.65 ± 0.44	ND
Sediment	0.27 ± 0.08*	0.02 ± 0.01**

Notes:

All values are presented with 95% confidence interval.
See Figure 5-8 for sampling locations.

ND = Not detected

NR = Not reported

* The potassium-40 (K-40) concentration was reported as an estimated value by the analytical laboratory.

** The cesium-137 (Cs-137) concentration was reported as an estimated value by the analytical laboratory.

favorable results in 2003. Chronic toxicity testing will resume in 2005 under the requirements of the SPDES discharge permit.

6.7 RADIOLOGICAL MONITORING OF PRECIPITATION

As part of the BNL Environmental Monitoring Program, precipitation samples were collected quarterly at air monitoring Stations P4 and S5 (see Figure 4-4 for station locations), and were analyzed for radiological content. Four samples were taken from each of these two stations in 2004. Gross alpha activity measurements above the MDL were found in the first quarterly samples taken at Stations P4 and S5. The value at P4 was 1.03 pCi/L, and the estimated value from the sample at S5 was 1.41 pCi/L. Both of these values are within the range of historic values

Table 6-8. Metals Analyses of Aquatic Vegetation and Sediment from the Peconic River System and Carmans River, Lower Lake Control Location.

Location/ Sample Type	mg/kg									
	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel
Forge Pond										
Lily Pad	< MDL	26.8	0.14	0.17	0.41	93	< MDL	50	0.001	0.186
Sediment	0.40	7.23	0.28	1.19	0.90	756	1.8	9.4	0.023	0.557
Swan Pond										
Lily Pad	0.32	15.2	< MDL	< MDL	0.27	17	< MDL	74.2	0.004	0.22
Sediment	8.70	110	2.20	19.00	23.90	5660	81.7	3340	0.200	15.4
HC										
Vegetation	< MDL	4.93	< MDL	0.16	0.82	88	< MDL	94.4	0.035	0.262
Sediment	1.23	2.49	0.09	2.10	3.50	3130	12.5	10.4	0.007	0.259
Lower Lake, Carmans River										
Vegetation	< MDL	63.5	< MDL	0.16	< MDL	36	< MDL	47.8	0.004	0.668
Sediment	5.28	140	0.90	28.90	7.61	9790	35.2	1220	0.122	5.150
										18.1
										40

Notes:

See Figure 5-8 for sampling locations.

MDL = Minimum Detection Limit

Table 6-9. Pesticide and PCB Analyses of Aquatic Vegetation, Water, and Sediment from the Peconic River System and Carmans River, Lower Lake Control Location.

Location/ Sample Type	Alpha-BHC	Lindane	Heptachlor	4,4'-DDE	4,4'-DDD	4,4'-DDT	Aroclor-1254
μg/kg							
Forge Pond							
Lily Pad	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL
Water (μg/L)	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL
Sediment	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL
Swan Pond							
Lily Pad	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL
Water (μg/L)	< MDL	< MDL	< MDL	0.008*	< MDL	< MDL	< MDL
Sediment	< MDL	< MDL	< MDL	69.2*	66	< MDL	< MDL
HC							
Vegetation	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL
Water (μg/L)	< MDL	< MDL	< MDL	< MDL	< MDL	0.036*	< MDL
Sediment	0.208*	0.161*	0.178*	< MDL	< MDL	0.630*	109
Lower Lake, Carmans River							
Vegetation	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	8.9*
Sediment	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL	< MDL

Notes:

Water values are reported in μg/L.

See Figure 5-8 for sampling locations.

MDL = Minimum Detection Limit

*The concentration was reported as an estimated value by the analytical laboratory.

reported for gross alpha activity and are considered to be background.

Gross beta activity was measured in three samples from Station P4 (all quarters but the third), and in all four samples from Station S5. In general, radioactivity in precipitation comes from naturally occurring radionuclides in dust and from activation products that result from solar radiation. Location P4 had a maximum gross beta activity level of 5.8 pCi/L, with an average of 3.50 pCi/L. Location S5 had a maximum gross beta activity level of 6.6 pCi/L, with an average of 3.89 pCi/L. Gross beta activity values were within the range of values historically observed at these two locations. No radionuclide-specific analyses indicated values above method detection limits.

6.8 WILDLIFE PROGRAMS

BNL sponsors a variety of educational and outreach activities involving natural resources. These programs are designed to help participants understand the ecosystem and to foster interest in science. Wildlife programs are con-

ducted 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 2003, the Environmental and Waste Management Services Division (EWMSD) hosted seven student interns and two high school teachers during the summer. Interns worked on a variety of subjects, including surveys of dragonflies and damselflies, radio telemetry of turtles and snakes, and analyzing the water chemistry of coastal plain ponds. A limited discussion concerning each project is presented below. These research efforts can be viewed at http://www.bnl.gov/esd/reserve/Posters_and_Presentations.htm.

An intern from the Community College of Rhode Island continued work on the identification and distribution of dragonflies and damselflies (Order *Odonata*) that was started in 2003. These aquatic insects are common around the ponds and the Peconic River on site. The dis-

tribution of aquatic invertebrates may be useful for monitoring the health of aquatic systems. In addition, results from the Odonate surveys are expected to supplement a planned state-wide survey of these insects in the near future. The number of species identified by the intern increased from 30 to 46 and detailed information on the distribution of each species across most of the Laboratory site was developed. This project is planned for continued work over the next several years.

Two other interns from the Community College of Rhode Island also worked on projects. One revisited and mapped the distribution of aquatic plants associated with the restoration of the Area D pilot study project associated with the Peconic River. This project provided information on the rapid spread of invasive grasses in the area and will benefit the future management of the river. Additionally, this intern was responsible for most of the transfer of wildlife from the river site, especially banded sunfish, prior to and during the on-site Peconic River cleanup project. The third intern worked on the comparison of species richness and recruitment at three ponds on site.

An intern from North Carolina State University conducted radio telemetry tracking of the eastern hognose snake (*Heterodon platyrhinos*). The biologist for the Upton Reserve started this project in 2003 and continued to oversee it. The project has greatly increased the understanding of the habitat needs of this locally rare snake and its vulnerability to predation and accidental death from vehicles. This project will be continued in the summer of 2005.

The fifth intern, from the University of Massachusetts at Amherst, conducted radio telemetry studies on captive-reared spotted turtles (*Clemmys guttata*). Several turtles were hatched at the Cold Spring Harbor Fish Hatchery and Museum, then outfitted with transmitters and released at BNL. The intern followed the tagged turtles, documenting their movements and use of habitat. The information gained may be helpful in determining the efficacy of captive rearing and release of this species as a means to improve the population levels. This project also is scheduled to continue in 2005.

The sixth intern, from the University of Hull in the United Kingdom, conducted research on the emergence of metamorphic salamanders and their dependence on rainfall. This study was a followup of research conducted near two ponds in 2001 using “cover boards” (sheets of wood placed on the ground as attractive habitat). The present research utilized drift fences around three ponds and correlated the emergence of eastern tiger salamanders and marbled salamanders with rainfall. This research is helpful in planning future trapping that will be necessary as part of a doctoral research project scheduled to begin in the spring of 2005.

A seventh intern, from the Los Angeles Mission College in California, conducted a statistical review and analysis of seasonal patterns in Cs-137 uptake in white-tailed deer. This work, as mentioned in Section 6.3.1.1, was important as it showed a definite seasonal pattern in Cs-137 levels in deer.

Two teachers working under a new DOE Office of Education Program called Laboratory Science Teacher Professional Development (LSTPD), conducted water quality surveys of many of the ponds on site. During this process, the two teachers developed skills and lesson plans that can be introduced into their classrooms. They are planning to share their work with fellow teachers to create interactive classroom activities. This 3-year program will continue in 2005 and 2006. The work this team conducted has also provided needed understanding about the water chemistry in several key coastal plain ponds that are habitat to a diversity of wildlife.

In addition to hosting interns, members of EWMSD and other BNL departments volunteered as speakers for schools and civic groups and provided on-site ecology tours. EWMSD also hosted events in association with Earth Day and provided activities to educate Laboratory employees and the general public on the environment and conservation during a Summer Sunday event in July. In October, BNL hosted the Ninth Annual Pine Barrens Research Forum, providing a venue for researchers who are conducting work on Pine Barrens ecosystems to share and discuss their results. BNL also

hosted the annual Wildland Fire Academy, offered by NYSDEC and the Central Pine Barrens Commission. This academy trains fire fighters in the methods of wildland fire suppression, prescribed fire, and fire analysis, using the Incident Command System of wildfire management.

BNL has been working over the past few years to develop and implement a *Wildland Fire Management Plan*. In late 2003, the plan was completed and approved, and a fire plan was written for the first prescribed fire at BNL. Once the prescribed fire plan was approved, BNL began educating its neighbors and preparing for implementation of the plan. In October 2004, the first prescribed fire at BNL was conducted. This fire treated approximately 7 acres to improve germination and recruitment of oak seedlings. It also reduced fine-textured forest fuels that tend to increase the severity of wildfires. Pre-fire monitoring was conducted before the fire was started, and post-fire monitoring indicated the fire was conducted properly for its intended purpose. Additional post-fire monitoring will be conducted in the spring and early summer of 2005 to see if the fire was beneficial for oak seedling recruitment. Future fires are planned for BNL and will be conducted as part of the annual Wildland Fire Academy.

6.9 CULTURAL RESOURCE ACTIVITIES

The BNL Cultural Resource Management (CRM) Program ensures that the Laboratory fully complies with the numerous cultural resource regulations. BNL submitted a draft *BNL Cultural Resource Management Plan* to DOE in December 2003, which outlines the management of all of BNL's cultural resources. Along with achieving compliance with applicable regulations, one of the major goals of the CRM program is to fully assess both known and potential cultural resources. The range of BNL cultural resources includes: buildings and structures, World War I earthwork features, the Camp Upton Historical Collection, scientific equipment, photo/audio/video archives, and institutional records. As various cultural resources are identified, plans for their long-term stewardship will be developed and implemented. Achieving these goals will ensure that the contributions

BNL and the site have made to U.S. history and culture are documented and available for interpretation.

BNL has three structures/sites that have been determined to be eligible for listing on the National Register of Historic Places: the Brookhaven Graphite Research Reactor (BGRR) complex, the High Flux Beam Reactor (HFBR) complex, and the World War I training trenches associated with Camp Upton. The BNL trenches may be the only surviving examples of World War I earthworks in the United States.

In 2004, BNL contracted with a qualified outside organization to survey and evaluate the architectural significance of Berkner Hall (Building 488), the Chemistry Building (Building 555), and other structures. The project included inspecting Brookhaven Center (Building 30, circa 1930s), Building 120 (former WW II barracks), the BGRR and laboratory (Buildings 701–703), the HFBR (Building 750), and the Medical Hot Laboratory (Building 801). The goal of the project was to identify key architectural features and assist BNL to develop management strategies for the future treatment of these structures.

The evaluation concluded that Berkner Hall and the Chemistry Building are architecturally significant resources that appear to be eligible for listing on the National Register of Historic Places. Berkner Hall is an excellent example of Expressionist-style architecture as it was applied to public buildings in the mid-twentieth century, and is representative of the work of the noted architectural firm of Urbahn Architects, an important U.S. architectural and engineering firm. Berkner Hall also possesses significance as an example of precast concrete slab construction and engineering. The Chemistry Building is a significant example of the conceptual work of Marcel Breuer, a major figure in twentieth-century architecture who developed the conceptual design of the building (PAL 2004).

Another contracted project performed in 2004 was the archeological evaluation of two sites believed to date to the 1800s. The sites are known as the Weeks Campbell site and the W.J. Weeks House site (Figure 6-6). The purpose of the site evaluations was to delineate the horizontal and

- a. Foundation/cellar hole at Weeks Campbell Archeological Site (circa late 1800's).
- b. Brickwork uncovered at Weeks Campbell Archeological Site (circa late 1800's).
- c. Locust wood fence post identified at W.J. Weeks House Site (circa 1830's).
- d. Foundation wall stone – W.J. Weeks House Site (circa 1830's).

Figure 6-6. Archeological Sites Surveyed in 2004.

vertical boundaries of cultural deposits, and to obtain information on the structure, function, cultural/historical context, significance, and integrity of each site. This information will be used to evaluate the sites' potential eligibility for the National Register of Historic Places, and includes recommendations for site protection.

The archeological site evaluations consisted of both archival research and field investigations. The main occupation of the Weeks Campbell site was determined to be late nineteenth–early twentieth century. This site has a relatively high degree of integrity, with several surface and subsurface features (agricultural landscape markers, the brick walkway, and most important to archeologists, the foundation/cellar hole). The archeologists dated the W.J. Weeks House site to the mid- to late-nineteenth century, and recommended protective measures to prevent potential site looting and disturbance. As a result, fencing was erected and warning signs were posted around the perimeter. Both sites may be eligible for listing on the National Register (Merwin and Manfra 2005).

Another goal of the CRM program is to formalize an oral history program for the Laboratory. In 2004, Robert Crease, BNL Historian, conducted four video interviews that included a long-time employee of the Chemistry Department and three individuals associated with the early development and construction of the National Synchrotron Light Source.

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Groundwater Protection

The Brookhaven National Laboratory (BNL) Groundwater Protection Management Program is made up of four elements: prevention, monitoring, restoration, and communication. BNL has implemented aggressive pollution prevention measures to protect groundwater resources. BNL's extensive groundwater monitoring well network is used to verify that prevention and restoration activities are effective. In 2004, BNL collected groundwater samples from 828 monitoring wells during 2,207 individual sampling events. Twelve groundwater remediation systems removed 652 pounds of volatile organic compounds and returned approximately 1.5 billion gallons of treated water to the Upper Glacial aquifer. Since the beginning of active groundwater remediation in December 1996, BNL has removed 4,808 pounds of volatile organic compounds by treating nearly 8.4 billion gallons of groundwater.

7.1 THE BNL GROUNDWATER PROTECTION MANAGEMENT PROGRAM

The primary 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 manner that is consistent with applicable federal, state, and local regulations. BNL's program helps to fulfill the environmental monitoring requirements outlined in DOE Order 450.1, *Environmental Protection Program*. This program is described in the *BNL Groundwater Protection Management Program Description* (Paquette et al. 2002). The BNL Groundwater Protection Program consists of four interconnecting elements: 1) preventing pollution of the groundwater, 2) monitoring the effectiveness of engineered and administrative controls at operating facilities and groundwater treatment systems, 3) restoring the environment by cleaning up contaminated soil and groundwater, and 4) communicating with stakeholders on groundwater protection issues. BNL is committed to protecting groundwater resources from further chemical and radionuclide releases, and to remediating existing contaminated groundwater.

7.1.1 Prevention

As part of BNL's Environmental Management System, the Laboratory has implemented a number of pollution prevention activities that are designed to protect groundwater resources (see Chapter 2). BNL has established a work control program that requires all experiments and industrial operations be reviewed to determine the potential impacts of these activities on the environment. This program enables BNL to integrate pollution prevention and waste minimization, resource conservation, and compliance into planning and decision-making. Efforts have been implemented to achieve or maintain compliance with regulatory requirements and to implement best management practices designed to protect groundwater (see Chapter 3). Examples include upgrading underground storage tanks (USTs), closing cesspools, and adding engineered controls (e.g., barriers to prevent rainwater infiltration that could move contaminants out of the soil and into groundwater) and administrative controls (e.g., reducing the toxicity and volume of chemicals in use or storage). Samples from groundwater monitoring wells are used to confirm that these controls are working.

7.1.2 Monitoring

BNL's groundwater monitoring network is designed to evaluate the impacts of groundwater contamination from former and current operations and to track cleanup progress (see Table 7-1). Results from groundwater monitoring are used to verify that protection and restoration efforts are working. Groundwater monitoring is focused on two general areas: 1) Environmental Surveillance (ES) monitoring, designed to satisfy DOE and New York State monitoring requirements for active research and support facilities, and 2) Environmental Restoration (ER) monitoring related to BNL's obligations under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). This monitoring is coordinated to ensure completeness and to prevent duplication of effort in the installation, monitoring, and abandonment of wells. The monitoring program elements have been integrated and include data quality objectives; plans and procedures; sampling and analysis; quality assurance; data management; and the installation, maintenance, and abandonment of wells. These elements were integrated to create a cost-effective monitoring system and to ensure that water quality data are available for review and interpretation in a timely manner.

7.1.3 Restoration

BNL was added to the National Priorities List in 1989 (see Chapter 2 for a discussion of BNL's ER Program). To help manage the restoration effort, 30 separate Areas of Concern were grouped into seven Operable Units (OUs). Remedial Investigation/Feasibility Studies have been conducted for each OU, and the focus is now on installing and operating cleanup systems. Contaminant sources (e.g., contaminated soil and USTs) are being removed or remediated to prevent further contamination of groundwater. All remediation work is carried out under the Interagency Agreement involving EPA, the New York State Department of Environmental Conservation (NYSDEC), and DOE.

7.1.4 Communication

BNL's Community Education, Government and Public Affairs (CEGPA) Program ensures

Table 7-1. Summary of BNL Groundwater Monitoring Program, 2004.

	Environmental Restoration Program	Environmental Surveillance Program
Number of wells monitored	703	125
Number of sampling events	1,889	318
Number of analyses performed	4,456	692
Number of results	74,315	7,548
Percent of nondetectable analyses	92	90
Number of new wells installed (a)	56	0
Number of wells abandoned	0	0

Notes:

(a) Permanent wells only. Single-use temporary wells used for characterization are not included.

that BNL communicates with the community in a consistent, timely, and accurate manner. A number of communication mechanisms are in place, such as press releases, web pages, mailings, public meetings, briefings, and roundtable discussions. Specific examples include routine meetings with the Community Advisory Council and the Brookhaven Executive Roundtable (see Chapter 2). In addition, quarterly and annual technical reports that summarize data, evaluations, and program indices are prepared.

7.2 GROUNDWATER PROTECTION PERFORMANCE

Since 1998, the BNL Groundwater Protection Management Program has been tracking progress toward preventing new contamination of the aquifer system. The Laboratory has made significant investments in environmental and groundwater protection, and is making progress in achieving its goal of preventing new groundwater impacts. A new groundwater impact is defined as the detection and confirmation of unusual or off-normal groundwater monitoring re-

sults. The *Groundwater Protection Contingency Plan* (BNL 2000) is designed to ensure that appropriate and timely actions are taken if unusual or off-normal results are observed. The contingency plan provides guidelines for evaluating the source of the problem, notifying stakeholders, and implementing appropriate corrective actions.

Since 1998, BNL has installed several hundred permanent and temporary monitoring wells as a result of a comprehensive evaluation of known or potential contaminant source areas. Using this enhanced monitoring system, BNL identified 10 new groundwater impacts during 1998 through 2001 (see Figure 7-1). No additional impacts have been identified since 2001. Five of the 10 identified impacts were determined to be from historical (or “legacy”) contaminant releases, and the other five were related to active science operations and environmental protection activities. In all 10 cases, BNL thoroughly investigated the cause of the contamination and took corrective actions as necessary to eliminate or limit the level or magnitude of these impacts. The Laboratory will continue efforts to prevent new groundwater impacts, and is vigilant in measuring and communicating its performance in groundwater protection.

7.3 GROUNDWATER MONITORING

Elements of the groundwater monitoring program include installing monitoring wells; planning and scheduling; developing and following quality assurance procedures; collecting and analyzing samples; verifying, validating, and interpreting data; and reporting. Monitoring wells (which are not used for the drinking water supply) 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 site.

BNL 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. The groundwater beneath the BNL site is classified by New York State as Class GA groundwater, which is defined as a source of potable water supply. Federal drinking water standards (DWS), New York State DWS, and New York State Ambient Water Quality Standards (NYS AWQS) for Class GA groundwater are used as goals for groundwater protection and remediation. BNL evaluates the potential impact of radiological and nonradiological contamination by comparing analytical

Figure 7-1. Groundwater Protection Performance, 1998 – 2004.

results to these standards. Contaminant concentrations that are below these standards are also compared to background values to evaluate the potential effects from facility operations. The detection of low concentrations of facility-specific volatile organic compounds (VOCs) or radionuclides may provide important early indications of a contaminant release and allow for timely identification and remediation of the source.

Groundwater quality at BNL is routinely monitored through a network of approximately 828 on- and off-site wells (see SER Volume II, *BNL Groundwater Status Report*, for details). In addition to water quality assessments, water levels are routinely measured in more than 875 on- and off-site wells to assess variations in the direction and velocity of flow. Groundwater flow directions in the vicinity of BNL are shown in Figure 7-2.

Among the active facilities that have groundwater monitoring programs are the Sewage Treatment Plant and Peconic River area, Service Station Motor Pool, Waste Management Facility, Central Steam Facility and adjacent Major Petroleum Facility, Alternating Gradient Synchrotron, Relativistic Heavy Ion Collider, Waste Concentration Facility, and several other smaller facilities. Inactive facilities include the former Hazardous Waste Management Facility, two former landfill areas, the Brookhaven Graphite Research Reactor (BGRR), High Flux Beam Reactor (HFBR), and the Brookhaven Medical Research Reactor (BMRR). As the result of detailed groundwater investigations conducted over the past 15 years, six significant VOC plumes and eight radionuclide plumes have been identified (see Figures 7-3 and 7-4).

7.4 SUPPLEMENTAL MONITORING OF WATER SUPPLY WELLS

As discussed in Chapter 3, 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. This water is also used for cooling water purposes at a number of facilities. Most of BNL's water supply is obtained from a network of six large-capacity wells (wells 4, 6, 7, 10, 11, and 12). A

seventh well, number 9, is a small-capacity well that supplies process water to a facility where biological research is conducted. This well is not routinely monitored. The locations of the supply wells are shown in Figure 7-2.

The quality of the BNL potable water supply is monitored as required by the Safe Drinking Water Act (SDWA), and the analytical results are reported to the Suffolk County Department of Health Services. As required by SDWA, BNL also prepares an annual Water Quality Consumer Confidence Report (BNL 2005b) that is distributed to all employees and guests. Results of the SDWA-required monitoring are described in Chapter 3.

All of BNL's supply wells are screened within the Upper Glacial aquifer. Because of the proximity of the potable supply wells to known or suspected groundwater contamination plumes and source areas, BNL conducts a supplemental potable supply well monitoring program that includes testing for VOCs, anions, metals, and radiological parameters. During 2004, the BNL potable water system fully complied with all drinking water requirements. To better understand the geographical source of BNL's drinking water and to identify potential sources of contamination within these geographical areas, BNL prepared the *Source Water Assessment for Drinking Water Supply Wells* (Bennett et al. 2000). In 2003, the New York State Department of Health prepared a Long Island Source Water Assessment for all potable water supply wells on Long Island (Summary Report NYSDOH 2003). The source water assessments are designed to serve as management tools in further protecting Long Island's sole source aquifer system.

7.4.1 Radiological Results

During 2004, samples collected quarterly from supply wells 6, 7, 11, and 12 were analyzed (see Table 7-2) for gross alpha and gross beta activity, tritium, and Sr-90. Because low levels of tritium were detected in a monitoring well at the Waste Management Facility, nearby supply wells 11 and 12 were tested for tritium more frequently. (Note: Well 10, which was used infrequently during 2004, was only sam-

Figure 7-3. Extent of VOC Plumes.

Table 7-2. Potable Well Radiological Analytical Results.

Potable Well ID		Gross Alpha	Gross Beta	Tritium
		pCi/L		
Well 4	Samples	WS	WS	WS
	Max.	—	—	—
	Avg.	—	—	—
Well 6	Samples	4	4	4
	Max.	< 0.74	2.20 ± 1.20	< 310
	Avg.	0.36 ± 0.37	1.53 ± 0.56	-28 ± 25
Well 7	Samples	4	4	4
	Max.	< 0.88	< 1.60	< 310
	Avg.	0.04 ± 0.28	0.69 ± 0.48	1 ± 66
Well 11	Samples	4	4	8
	Max.	< 0.09	< 1.70	< 300
	Avg.	0.09 ± 0.30	0.77 ± 0.40	79 ± 77
Well 12	Samples	4	4	8
	Max.	< 0.87	2.40 ± 1.30	340 ± 220
	Avg.	0.41 ± 0.32	1.48 ± 0.76	106 ± 107
SDWA Limit (pCi/L)		15 (a)	4 mrem (b)	20,000

Notes:

See Figure 7-2 for well locations.

All values presented with a 95% confidence interval.

Potable Well #10 was shut down most of the year due to its possible effect on groundwater flow direction in the vicinity of the g-2 Tritium Plume.

WS = Well shut down due to operational problems.

(a) Excluding radon and uranium.

(b) The drinking water standards were changed from 50 pCi/L (concentration based) to (dose based) in late 2003. Because gross beta activity does not identify specific radionuclides, a dose equivalent cannot be calculated for the values in the table.

pled under the compliance monitoring program described in Chapter 3.) Nuclide-specific gamma spectroscopy was also performed for potable well samples. Average gross activity levels in the potable water wells were consistent with those of typical background water samples. In 2004, tritium was the only BNL-related radionuclide that was observed above the minimum detection limit in the potable water samples. That tritium reading, from supply well 12, was 340 pCi/L; the minimum detection limit was 310 pCi/L and the DWS set by New York State and the SDWA is 20,000 pCi/L. Tritium was not detected in subsequent samples from this well.

7.4.2 Nonradiological Results

In addition to the quarterly SDWA compliance samples described in Section 3.7 of Chapter 3, BNL collected supplemental VOC samples from active supply wells during the year. These samples were analyzed for VOCs following either EPA Standard Method 524 or 624. Trace levels of chloroform continued to be routinely detected in samples from most wells, with a maximum concentration of 1.5 µg/L observed during 2004. The DWS for chloroform is 80 µg/L. Low levels of several other VOCs (e.g., 1,1,1-trichloroethane [TCA], bromodichloromethane, and dibromochloromethane) were occasionally detected, but at concentrations well below applicable DWS. Samples were also analyzed for metals and anions one time during the year from wells 6, 7, 11, and 12 (see Tables 7-3 and 7-4). As in previous years, iron was the only parameter detected at concentrations greater than the DWS, which is 0.3 mg/L for iron. Iron levels in wells 6 and 7 were 4.71 and 2.06 mg/L, respectively. Because high levels of iron are naturally present in some portions of the Upper Glacial aquifer on the western side of the BNL site, water obtained from wells 4, 6, and 7 is treated at the BNL Water Treatment Plant to reduce iron levels before distribution.

7.5 ENVIRONMENTAL SURVEILLANCE PROGRAM

BNL's ES Program includes groundwater monitoring at 10 active research facilities (e.g., accelerator beam stop and target areas) and support facilities (e.g., fuel storage facilities). During 2004, 125 groundwater wells were monitored during 318 individual sampling events. Detailed descriptions and maps related to the ES groundwater monitoring program can be found in SER Volume II, *Groundwater Status Report*.

Although no new impacts to groundwater quality were discovered during 2004, groundwater quality continues to be impacted at four facilities, as follows: continued high levels of tritium at the g-2/VQ-12 area of the Alternating Gradient Synchrotron (AGS) facility; tritium at the Brookhaven Linac Isotope Producer (BLIP) facility, and low-level VOCs at the Motor Pool/Facility Maintenance area and the Service

Station. Significant monitoring results for these areas are described below.

- Although tritium continues to be detected at concentrations above the 20,000 pCi/L drinking water standard in wells immediately downgradient of the g-2/VQ-12 source area in the AGS facility, the levels are much lower than those observed in 2002 and 2003. Tritium concentrations reached a maximum of 3,440,000 pCi/L in 2002 and have shown a steady decline, dropping to 93,200 pCi/L by October 2004.
- In January 2004, tritium concentrations slightly exceeded the 20,000 pCi/L standard in one well immediately downgradient of BLIP, with a concentration of 24,500 pCi/L. Tritium concentrations declined to less than the DWS limit of 20,000 pCi/L for the remainder of the year.
- At the Motor Pool/Site Maintenance area, the solvents TCA and 1,1-dichloroethane (DCA) continued to be detected at concentrations greater than the NYS AWQS of 5 µg/L, but at concentrations that were lower than those observed during 2003. TCA was detected at concentrations up to 38 µg/L, and DCA was detected at concentrations up to 13 µg/L. The gasoline additive methyl tertiary butyl ether (MTBE) was also detected, with a maximum observed concentration of 18 µg/L. The NYS AWQS for MTBE is 10 µg/L.
- At the Service Station, VOCs associated with petroleum products and solvents continued to be detected in several monitoring wells directly downgradient of the station, but at concentrations that were lower than those observed during 2003. Petroleum-related compounds detected in groundwater included m/p xylene at 67 µg/L, o-xylene at 79 µg/L, 1,2,4-trimethylbenzene at 16 µg/L, and 1,3,5-trimethylbenzene at 24 µg/L. The solvent tetrachloroethylene (TCE) was detected in several wells at a maximum concentration of 20 µg/L. MTBE was also detected, at a maximum concentration of 14 µg/L.

Table 7-3. Potable Water Supply Wells Water Quality Data.

Potable Well ID		Chlorides	Sulfates	Nitrate and Nitrite
		mg/L		
Well 4	N	WS	WS	WS
	Value	—	—	—
Well 6	N	1	1	1
	Value	20.9	12.8	2.7
Well 7	N	1	1	1
	Value	22.7	9.0	3.1
Well 11	N	1	1	1
	Value	17.9	< 0.5	5.6
Well 12	N	1	1	1
	Value	20.8	11.5	5.8
NYS DWS		250	250	10
Typical MDL		4	4	1

Notes:

See Figure 7-2 for location of wells.

Potable Well #10 was shut down most of the year due to its possible effect on groundwater flow direction in the vicinity of the g-2 Tritium Plume.

N = Number of samples

NYS DWS = New York State Drinking Water Standard

MDL = Minimum Detection Limit

WS = Well shut down due to operational problems.

Although the engineered stormwater controls appeared to be effectively protecting the g-2/VQ-12 and BLIP source areas, monitoring data suggested that the continued release of tritium in both areas appeared to be caused by the flushing of residual tritium from the vadose (or unsaturated) zone following significant natural periodic rises in the local water table. It is expected that the amount of tritium remaining in the vadose zone close to the water table will decline over time due to this flushing mechanism and by natural radioactive decay (the half-life of tritium is 12.3 years).

Monitoring of the leak detection systems at both vehicle maintenance facilities indicated that the gasoline storage tanks and associated distribution lines were not leaking. Furthermore, evaluation of vehicle maintenance operations

Table 7-4. Total Metals Concentration Data for Potable Water Supply Well Samples.

Well ID	Ag	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg	Mn	Na	Ni	Pb	Sb	Se	Tl	V	Zn
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Well 4*	N	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS	WS
Value	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Well 6*	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Value	<2.0	<50.0	3.0	23.8	<2.0	<2.0	0.7	1.9	11.0	4.71	<0.2	71.1	14.7	3.2	<3.0	<5.0	1.4	0.46	<5.0	6.2
Well 7*	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Value	<2.0	<50.0	1.3	20.3	<2.0	<2.0	0.48	<5.0	4.3	2.06	<0.2	57.9	16.1	1.2	<3.0	<5.0	<5.0	<5.0	<5.0	5.7
Well 11	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Value	<2.0	<50.0	0.71	26.4	<2.0	<2.0	7.5	<5.0	7.5	0.05	<0.2	<5.0	15.1	0.41	<3.0	<5.0	<5.0	1.4	<5.0	3.8
Well 12	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Value	<2.0	<50.0	<5.0	28.7	<2.0	0.04	1.0	<5.0	5.7	<0.05	<0.2	<5.0	16.0	0.51	1.3	<5.0	<5.0	0.9	<5.0	4.8
NYS DWS	100	SNS	50	2000	4	5	SNS	100	1300	0.3	2	300	SNS	SNS	15	6	50	2	SNS	5000
Typical MDL	1.0	2.2	3.0	1.8	0.7	1.1	0.1	1.0	2.0	0.08	0.1	5.0	1.0	1.1	1.3	0.9	5.0	0.7	5.5	4.0

Notes:

See Figure 7-2 for location of wells.

Potable Well #10 was shut down most of the year due to its possible effect on groundwater flow direction in the vicinity of the g-2 Tritium Plume.

* Water from these wells is treated at the Water Treatment Plant for color and iron reduction prior to site distribution.

MDL = Minimum Detection Limit

NYS DWS = New York State Drinking Water Standard

SNS = Drinking Water Standard not specified

WS = Well shut down due to operational problems

in 2004 indicated that all waste oils and used solvents were being properly stored and recycled. Therefore, it is believed that the contaminants detected in groundwater at these facilities originated from historical vehicle maintenance activities, and were not related to current operations.

7.6 ENVIRONMENTAL RESTORATION GROUNDWATER MONITORING PROGRAM

The mission of the Environmental Restoration Groundwater Monitoring Program is to monitor the contaminant plumes on and off site. The monitoring results are used to track the progress that the groundwater treatment systems are making toward plume remediation. In 2004, a total of 703 groundwater wells were monitored, in 1,889 individual sampling events.

Maps showing the main VOC and radionuclide plumes are provided as Figures 7-3 and 7-4, respectively. Detailed descriptions and maps related to the ER Groundwater Monitoring Program can be found in SER Volume II. Highlights of the ER Groundwater Monitoring Program are described below.

- During 2004, high levels of tritium were periodically detected in groundwater immediately downgradient of the HFBR, especially in wells 075-43 and 075-245. Tritium concentrations in monitoring well 075-43, located on the HFBR lawn, increased to 378,000 pCi/L in February. As this high level slug of tritium continued to migrate downgradient, in October it was detected in well 075-245, located just south of Cornell Avenue, at a concentration of 433,000 pCi/L. Similar to the g-2/VQ-12 and BLIP source areas described in Section 7.5,

the periodic detection of high levels of tritium downgradient of the HFBR indicates that residual tritium continues to be flushed out of the unsaturated zone close to the water table by natural water table fluctuations. It is expected that the amount of tritium remaining in the vadose zone close to the water table will decline over time due to this flushing mechanism and by natural radioactive decay. In the downgradient section of the plume, south of Brookhaven Avenue, the highest tritium concentration was detected in the vicinity of Grove and Rowland Streets, where a tritium concentration of 55,000 pCi/L was detected in temporary well 085-344. The leading edge of the plume, as defined by concentrations greater than the 20,000 pCi/L drinking water standard, is estimated to be just north of the Chilled Water Plant Road. Monitoring data indicate that the plume continues to attenuate as expected.

- Monitoring in the Building 96 area indicated that concentrations of VOCs (primarily PCE and TCA) downgradient of treatment well RTW-1 were less than the 5 µg/L NYS AWQS. As a result of this concentration reduction, downgradient treatment wells RTW-2, -3, and -4 were placed in standby mode in July 2004. However, higher levels of VOC contamination continued to be detected in the “silt zone” source area north of RTW-1. Starting in June 2004, additional groundwater characterization work was performed in the silt zone source area using temporary and permanent wells. High levels of VOCs were found, with PCE concentrations up to 3,800 µg/L and TCA concentrations up to 160 µg/L. An *in situ* method of chemical oxidation was chosen to treat this contamination. As a result, potassium permanganate was injected into the silt zone source area in late 2004 and early 2005.
- The operation of the OU III Carbon Tetrachloride Treatment System has significantly reduced carbon tetrachloride

levels in groundwater near the former UST source area. Carbon tetrachloride levels in that area decreased from a high concentration of 179,000 µg/L in November 1998 to 63 µg/L in November 2004. The highest carbon tetrachloride concentration during 2004 was 230 µg/L, detected in well 095-301, near the southernmost extent of the plume. As a result of the 99.9 percent decrease in the maximum carbon tetrachloride concentrations within the plume, a petition to shut down the treatment system was sent to the regulatory agencies (BNL 2004b). This petition was approved by the regulatory agencies in July, and the treatment system was placed in standby mode in August 2004.

- During 2004, 22 new groundwater monitoring wells were installed to enhance the well network downgradient of Sr-90 source areas near the BGRR and Waste Concentration Facility (WCF). The highest Sr-90 concentration observed within the BGRR plume was 1,240 pCi/L in a temporary well installed immediately south of Building 901, near Cornell Avenue. Sr-90 concentrations up to 706 pCi/L were observed downgradient of the WCF. Construction of the BGRR/WCF groundwater treatment system was completed in December 2004, and startup testing will begin in January 2005.
- During 2004, BNL installed 34 new off-site groundwater monitoring wells to help monitor the effectiveness and progress of the off-site groundwater treatment systems.

7.7 GROUNDWATER TREATMENT SYSTEMS

The primary mission of the Laboratory’s Environmental Restoration Program is to remediate soil and groundwater contamination and prevent additional contamination from migrating off the BNL site. The cleanup goals are to 1) prevent or minimize plume growth, and 2) reduce contaminant concentrations in the Upper Glacial aquifer to below NYS Maximum Contaminant Level (MCL) standards.

Table 7-5. BNL Groundwater Remediation Systems Treatment Summary for 1997 through 2004.

Remediation System	Start Date	1997–2003		2004	
		Water Treated (Gallons)	VOCs Removed (Pounds) (e)	Water Treated (Gallons)	VOCs Removed (Pounds) (e)
OU I South Boundary	12/1996	2,424,780,000	297	271,495,000	16
OU III HFBR Tritium Plume (a)	05/1997	241,528,000	180	Not in Service	0
OU III Carbon Tetrachloride (d)	10/1999	150,146,300	341	17,775	7
OU III Building 96	02/2001	98,265,416	55	24,600,000	12
OU III Middle Road	10/2001	614,353,550	364	194,000,000	156
OU III South Boundary	06/1997	2,254,859,850	2,104	310,000,000	172
OU III Western South Boundary	09/2002	213,048,000	22	144,000,000	10
OU III Industrial Park	09/1999	789,928,330	758	177,000,000	80
OU III Industrial Park East	05/2004	Not in Service	0	57,113,000	17
OU III North Street	06/2004	Not in Service	0	144,702,000	115
OU III North Street East	06/2004	Not in Service	0	84,000,000	5
OU III LIPA/Airport	06/2004	Not in Service	0	134,444,000	62
OU IV AS/SVE (b)	11/1997	(c)	35	Decommissioned	0
OU VI EDB	08/2004	Not in Service	0	20,000,000	<1 (f)
Total		6,786,909,446	4,156	1,542,597,775	652

Remediation System	Start Date	2003		2004	
		Water Treated (Gallons)	Sr-90 Removed (mCi)	Water Treated (Gallons)	Sr-90 Removed (mCi)
OU III Chemical Holes Sr-90	02/2003	3,834,826	0.88	1,226,000	0.39

Notes:

(a) System was shut down and placed in standby mode on September 29, 2000.

(b) System was shut down on January 10, 2001, and decommissioned in 2003.

(c) Air Sparging/Soil Vapor Extraction (AS/SVE) system performance is measured by pounds of VOCs removed per cubic feet of air treated.

(d) System was shut down and placed in standby mode in August 2004.

(e) Values are rounded to the nearest whole number.

(f) Ethylene dibromide (EDB) was not detected in the treatment system influent during 2004. However, other low-level VOCs not attributable to BNL were detected; the results were all below Maximum Contaminant Levels (MCLs), and were potentially the result of analytical laboratory contamination.

Based on additional information obtained during the Strontium-90 Pilot Study and Magothy aquifer characterization, BNL prepared the *OU III Explanation of Significant Differences* (BNL 2004a), which was submitted to the public for review in December 2004. This report identified changes to the OU III cleanup goal time frames. For the BGRR/WCF and Chemical Holes Sr-90 plumes, MCLs must be reached within 70 years and 40 years, respectively. Cleanup of the Magothy aquifer VOC contamination must meet MCLs within 65 years. With NYSDEC concurrence, the

EPA approved the *Explanation of Significant Differences* in early 2005.

All of the 16 planned groundwater remediation systems have been constructed. The HFBR Pump and Recharge System has remained in standby mode since September 2000, the OU IV Air Sparging/Soil Vapor Extraction System was decommissioned in 2003, and the Carbon Tetrachloride Plume Treatment System was placed in standby mode in August 2004 following regulatory agency approval. Furthermore, because VOC concentrations in three of the four Building 96 recirculation wells remained

significantly low, those wells were shut down and placed in standby mode in July 2004.

In 2004, BNL continued to make significant progress in restoring groundwater quality on site by having twelve groundwater remediation systems in active operation. Figure 7-5 shows the locations of the groundwater treatment systems. Table 7-5 provides a summary of pounds of VOCs and curies (Ci) of radioactivity removed, and gallons of water treated during 1997–2004. During 2004, 652 pounds of VOCs and 0.39 mCi of Sr-90 were removed from the groundwater and more than 1.5 billion gallons of treated groundwater were returned to the aquifer. To date, approximately 4,800 of the estimated 25,000 to 30,000 pounds of VOCs in the aquifer have been removed. It is expected to take up to 10 years of aquifer treatment before widespread improvements in groundwater quality at BNL are achieved. Even so, some noticeable improvements in groundwater quality are evident in the OU I South Boundary, OU III South Boundary, OU IV, Building 96, and Carbon Tetrachloride areas. Detailed information on the groundwater treatment systems can be found in SER Volume II.

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Radiological Dose Assessment

Brookhaven National Laboratory (BNL) routinely evaluates site operations to ensure that the radiological dose impact to the members of the public, BNL workers, and the environment is “As Low As Reasonably Achievable (ALARA).” All scientific and operational processes and activities that can in any way impact the health and safety or potentially contribute to radiological dose are reviewed for their environmental impacts. The potential radiological dose to the public is calculated as the maximum dose to a hypothetical Maximally Exposed Individual (MEI) at the BNL site boundary. Doses are calculated by considering all direct and indirect possible sources and pathways, such as inhalation of air emissions, ingestion of deer meat and fish, and any immersion dose. The dose assessment has routinely shown that the total effective dose equivalent from BNL activities is well below the EPA regulatory dose limits for the public, BNL workers, and the environment.

The average annual external dose from all potential ambient sources was 66 ± 11 mrem (660 ± 110 μ Sv) on site and 62 ± 10 mrem (620 ± 100 μ Sv) at off-site locations. Both measurements include contributions from natural background and cosmic radiation sources. A statistical comparison of the average doses measured at 47 on-site and 16 off-site thermoluminescent dosimeters (TLDs) showed that there was no additional external dose contribution from BNL operations above the dose from natural background radiation. In addition to these “background” measurements, nine TLDs were used to monitor known radiation source areas. The results of these measurements are described below.

The effective dose from air emissions was calculated as $4.40\text{E-}02$ mrem (0.44 μ Sv) to the MEI. The ingestion pathway dose was estimated as 1.31 mrem (13.1 μ Sv) from consumption of deer meat and 0.37 mrem (3.7 μ Sv) from consumption of pumpkinseed fish caught on the BNL site. The total annual dose to the MEI from all pathways was estimated as 1.72 mrem (17.2 μ Sv). The BNL dose from the air inhalation pathway was 0.4 percent of EPA’s annual regulatory dose limit of 10 mrem (100 μ Sv), and less than 2 percent of DOE’s annual dose limit of 100 mrem (1,000 μ Sv) from all pathways.

Doses to aquatic and terrestrial biota were also evaluated and found to be well below the DOE regulatory limits. Other short-term projects, such as remediation work and waste management disposal activities, conducted in 2004 were also evaluated for their radiological emissions and potential dose impact; there was no radiological risk to the public or the environment from these activities. In conclusion, the overall dose impact from all BNL activities in 2004 was indistinguishable from natural background radiation levels.

8.1 DIRECT RADIATION MONITORING

A direct radiation-monitoring program is used to measure the external dose contribution to members of the public and workers from

radiation sources at BNL. This is achieved by measuring direct penetrating radiation exposures both on and off site. The direct measurements taken at the off-site locations are with the

premise that off-site exposures are true natural background radiation (contribution from cosmic and terrestrial) exposures and represent no contribution from BNL operations. On- and off-site external doses were measured, averaged, and then compared using the statistical t-test to evaluate any variations and the contribution, if any, from BNL operations above natural background radiation.

Direct penetrating beta-gamma radiation is measured using TLDs. The principle of TLD operation is that when certain crystals are exposed to radiation, impurities in the crystals' low-temperature trapping sites are excited to higher energy states. These electrons remain in

a high-energy state at normal ambient temperature. When the TLDs are heated (annealed), the electrons return to the lower energy state. As the electrons return to the lower energy state, they emit photon energy (i.e., light), which is measured with a photomultiplier tube; the light intensity given out is directly proportional to the absorbed radiation dose. The environmental TLDs used at BNL are composed of calcium fluoride and lithium fluoride crystals. The TLDs' accuracy is verified by comparing the absorbed dose of the TLD to a known radiation source. Also, BNL participates in the inter-comparison proficiency testing programs sponsored by DOE.

Figure 8-1. On-Site TLD Locations.

8.1.1 Ambient Monitoring

To assess the dose impact of direct radiation from BNL operations, TLDs are deployed at the BNL site and in the surrounding communities. On-site TLD locations are determined based on the potential for exposure to gaseous air plumes, atmospheric particulates, scattered radiation, and the location of historical radiation-generating facilities. The BNL perimeter is also posted with environmental TLDs to assess the dose impact, if any,

beyond the Laboratory boundary. On- and off-site locations are divided into grids and each TLD is assigned an identification code based on these grids.

In 2004, 56 TLDs were deployed on site, of which nine were placed in known radiation areas (i.e., facility area monitoring TLDs) and 16 were deployed off site (see Figures 8-1 and 8-2 for locations). An additional 30 control TLDs were stored in a lead-shielded container in

Building 490; the average of the control TLDs is reported as “075-TLD4” in Tables 8-1 and 8-2, for comparison. Note that some residual dose remains on the control TLDs when they are annealed and it is impossible to completely shield the control devices from all natural background and cosmic radiation sources. Therefore, small doses are measured by the control TLDs. The on- and off-site TLDs are collected and read quarterly to determine the external radiation dose measured.

Table 8-1 shows the quarterly and yearly on-site radiation dose measurements. The on-site average external dose for the first, second, third, and fourth quarters was 17.2 ± 3.3 , 15.8 ± 3.6 , 15.7 ± 3.2 , and 17.5 ± 3.2 mrem, respectively. The annual on-site external dose from all potential environmental sources, including cosmic and terrestrial radiation sources, was 66 ± 11 mrem. Table 8-2 shows the quarterly and yearly off-site radiation dose measurements. The off-site average external dose for the first, second, third, and fourth quarters was 15.9 ± 2.7 , 14.7 ± 2.4 , 15.2 ± 3.3 , and 16.1 ± 2.7 mrem, respectively. The annual off-site average ambient dose was 62 ± 10 mrem. To determine the

BNL contribution to the external direct radiation dose, a statistical t-test between the measured on-site and off-site external dose averages was conducted. The t-test showed that there was no significant difference between the off-site dose (62 ± 10 mrem) and on-site dose (66 ± 11 mrem). From these measured doses, it can be safely concluded that there was no external dose contribution to on- and off-site locations from BNL operations in 2004.

8.1.2 Facility Area Monitoring

Nine of the 56 on-site TLDs were designated as the Facility Area Monitors (FAM). These TLDs are deployed at locations known to have radiation contamination, possible radiation scatter, or are in proximity to radiological posted areas with a higher probability to potentially contribute to the external radiation doses. Table 8-3 shows the external doses measured with the FAM TLDs. Environmental TLDs are posted at the S-6 blockhouse location and on the fence of the former Hazardous Waste Management Facility (HWMF) (088-TLD1 through 088-TLD4). These TLDs measured much higher external dose than typical natural background

Table 8-1. On-Site Direct Radiation Measurements.

TLD#	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Avg./Qtr. $\pm 2\sigma$ (95%)	Annual Dose $\pm 2\sigma$ (95%)
		mrem					
011-TLD1	North firebreak	14.5	13.8	15.0	16.0	15 ± 2	59 ± 7
013-TLD1	North firebreak	17.9	13.8	13.8	15.2	15 ± 4	61 ± 15
025-TLD1	Bldg. 1010 beam stop 1	17.9	13.4	14.3	16.7	16 ± 4	62 ± 16
025-TLD4	Bldg. 1010 beam stop 4	16.7	14.1	14.9	16.7	16 ± 3	62 ± 10
027-TLD1	Bldg. 1002A South	15.5	15.9	13.8	14.9	15 ± 2	60 ± 7
027-TLD2	Bldg. 1002D East	15.3	16.5	13.5	15.2	15 ± 2	61 ± 10
030-TLD1	NE Firebreak	16.5	17.7	17.3	18.5	17 ± 2	70 ± 7
034-TLD1	Bldg. 1008 collimator 2	18.0	15.9	15.6	18.4	17 ± 3	68 ± 11
034-TLD2	Bldg. 1008 collimator 4	18.2	14.9	15.4	17.7	17 ± 3	66 ± 13
036-TLD1	Bldg. 1004B East	16.7	13.3	14.3	15.3	15 ± 3	60 ± 11
036-TLD2	Bldg. 1004 East	20.4	19.3	17.0	20.4	19 ± 3	77 ± 12
037-TLD1	S-13	15.8	14.0	14.6	17.2	15 ± 3	62 ± 11
043-TLD1	North access road	17.5	15.9	15.6	18.0	17 ± 2	67 ± 9
043-TLD2	North of Met. Tower	16.6	15.7	16.6	17.6	17 ± 2	67 ± 6

(continued on next page)

Table 8-1. On-Site Direct Radiation Measurements (concluded).

TLD#	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Avg./Qtr. ± 2σ (95%)	Annual Dose ± 2σ (95%)
		mrem					
044-TLD1	Bldg. 1006	15.2	14.9	14.5	16.4	15 ± 2	61 ± 6
044-TLD2	South of Bldg. 1000E	15.3	15.1	15.1	17.0	16 ± 2	63 ± 7
044-TLD3	South of Bldg. 1000P	16.0	13.7	15.7	16.3	15 ± 2	62 ± 9
044-TLD4	NE of Bldg. 1000P	21.3	16.4	17.2	20.4	19 ± 5	75 ± 19
044-TLD5	N of Bldg. 1000P	16.8	15.3	15.2	17.9	16 ± 3	65 ± 10
045-TLD1	Bldg. 1005S	18.7	17.3	16.1	16.1	17 ± 2	68 ± 9
045-TLD2	East of Bldg. 1005S	17.5	16.2	16.7	19.1	17 ± 2	70 ± 10
045-TLD3	SE of Bldg. 1005 S	16.2	14.6	15.4	17.6	16 ± 2	64 ± 10
045-TLD4	SW of Bldg. 1005 S	15.9	15.0	15.6	18.2	16 ± 3	65 ± 11
045-TLD5	WSW of Bldg. 1005 S	13.8	13.0	12.8	16.2	14 ± 3	56 ± 12
049-TLD1	East firebreak	16.9	14.3	14.4	16.6	16 ± 3	62 ± 11
053-TLD1	West firebreak	19.6	17.5	17.3	19.3	18 ± 2	74 ± 9
054-TLD1	Bldg. 914	18.1	13.4	13.8	16.5	15 ± 4	62 ± 18
063-TLD1	West firebreak	19.2	17.2	16.9	18.7	18 ± 2	72 ± 9
066-TLD1	New HWM Facility	14.4	13.2	12.9	15.5	14 ± 2	56 ± 9
073-TLD1	W Meterology Twr. /Bldg. 51	16.9	15.5	18.8	18.4	17 ± 3	70 ± 12
074-TLD1	Bldg. 197	17.4	17.1	17.8	20.0	18 ± 3	72 ± 10
074-TLD2	Bldg. 907	17.4	13.7	15.2	16.5	16 ± 3	63 ± 13
080-TLD1	East firebreak	18.9	17.7	17.5	19.7	18 ± 2	74 ± 8
082-TLD1	West firebreak	18.5	17.9	18.0	20.0	19 ± 2	74 ± 8
084-TLD1	Tennis courts	17.6	17.2	17.3	18.9	18 ± 2	71 ± 6
085-TLD2	Upton gas station	19.2	17.7	15.4	17.6	17 ± 3	70 ± 12
085-TLD1	TFCU (Credit Union)	17.7	15.9	16.9	16.7	17 ± 1	67 ± 6
086-TLD1	Baseball fields	19.9	18.8	20.8	20.0	20 ± 2	80 ± 6
105-TLD1	South firebreak	17.9	20.5	16.4	19.6	19 ± 4	74 ± 14
108-TLD1	Water tower	15.4	16.2	15.6	16.5	16 ± 1	64 ± 4
111-TLD1	Trailer park	18.7	19.1	16.2	18.1	18 ± 2	72 ± 10
122-TLD1	South firebreak	15.4	15.0	15.1	17.2	16 ± 2	63 ± 8
126-TLD1	South gate	17.6	17.0	16.6	19.3	18 ± 2	71 ± 9
P2	North Firebreak	13.9	14.2	12.8	13.8	14 ± 1	55 ± 5
P4	Apartment Laundry	15.5	17.0	15.7	15.9	16 ± 1	64 ± 5
P7	South Firebreak	17.3	14.9	15.5	16.6	16 ± 2	64 ± 8
S5	Sewage Treatment Plant	18.5	14.7	14.5	16.3	16 ± 4	64 ± 15
On-site average		17.2	15.8	15.7	17.5	17 ± 3	66 ± 11
Std. dev. (2 σ)		3.3	3.6	3.2	3.2		
075-TLD4	Control TLD average	8.96	8.62	8.96	12	10 ± 3	39 ± 12

Note:

See Figure 8-1 for TLD locations.

Table 8-2. Off-Site Direct Radiation Measurements.

TLD#	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Avg./Qtr. $\pm 2\sigma$ (95%)	Annual Dose $\pm 2\sigma$ (95%)
		mrem					
000-TLD4	Private property	14.8	13.2	13.4	15.6	14 $\pm$ 2	57 $\pm$ 9
000-TLD5	Smith Estate	16.5	14.8	15.3	15.1	15 $\pm$ 1	62 $\pm$ 6
000-TLD7	Mid-Island Game Farm	16.1	14.3	14.7	15.8	15 $\pm$ 2	61 $\pm$ 7
200-TLD2	Private property	18.2	17.8	19.0	18.0	18 $\pm$ 1	73 $\pm$ 4
300-TLD2	Private property	NP	NP	NP	NP		
300-TLD3	Private property	16.4	15.1	16.8	16.1	16 $\pm$ 1	64 $\pm$ 6
400-TLD1	Calverton National Cemetery	17.0	15.6	17.7	17.2	17 $\pm$ 2	68 $\pm$ 7
500-TLD1	Private property	13.8	12.2	12.3	13.7	13 $\pm$ 2	52 $\pm$ 7
500-TLD2	Private property	14.8	14.2	14.1	15.2	15 $\pm$ 1	58 $\pm$ 4
500-TLD4	Private property	16.5	15.2	NR	NR	16 $\pm$ 2	63 $\pm$ 7
600-TLD3	Sportsmen's Club	15.5	14.5	15.1	17.5	16 $\pm$ 3	63 $\pm$ 10
700-TLD2	Private property	15.7	14.1	14.5	NR	15 $\pm$ 2	59 $\pm$ 7
700-TLD3	Private property	16.6	15.2	16.0	18.2	17 $\pm$ 2	66 $\pm$ 10
700-TLD4	Private property	16.4	14.4	14.5	17.1	16 $\pm$ 3	62 $\pm$ 11
800-TLD1	Private property	12.6	14.6	14.6	14.1	14 $\pm$ 2	56 $\pm$ 8
800-TLD2	Private property	NP	NP	NP	NP		
800-TLD3	Suffolk County CD	17.3	15.6	15.7	15.2	16 $\pm$ 2	64 $\pm$ 7
999-TLD1	Private property	16.7	13.6	13.9	16.4	15 $\pm$ 3	61 $\pm$ 13
Off-site average		15.9	14.7	15.2	16.1	15 $\pm$ 2	62 $\pm$ 10
Std. dev. (2 σ)		2.7	2.4	3.3	2.7		
075-TLD4	Control TLD average	8.96	8.62	8.96	12	10 $\pm$ 3	39 $\pm$ 12

Notes:

NP = TLD not posted for the quarter

NR = TLD was not returned for measurements

See Figure 8-2 for TLD locations.

dose measured at other BNL areas. The high external dose measured at the former HWMF can be attributed to the presence of contaminated soil as the result of historical radioactive waste management practices at the facility. The entire former HWMF was demolished in 2003 and excavation of the contaminated soil commenced in 2004. Comparison of the 2004 dose rates with rates from previous years shows that the dose rates have begun to decline from the removal of the radioactive soils. The former HWMF is currently posted as a radiological area. Only radiation-trained personnel wearing personal dosimeters are allowed inside the facility until all the contaminated soil has been remediated.

Two TLDs (075-TLD3 and 075-TLD5) posted near Building 356 have shown higher quarterly averages, 26 $\pm$ 9 mrem (260 $\pm$ 90 μ Sv) and 28 $\pm$ 8 mrem (280 $\pm$ 80 μ Sv), respectively. The yearly doses were measured as high as 105 $\pm$ 36 mrem (1050 $\pm$ 360 μ Sv) for 075-TLD3, and 110 $\pm$ 33 mrem (1100 $\pm$ 330 μ Sv) for 075-TLD5. The direct doses are significantly higher than the on-site annual average. Building 356 houses a cobalt-60 (Co-60) source, which is used to irradiate materials, parts, and electronic circuit boards. The elevated measurements here can be attributed to the "sky-shine" phenomenon and shielding of Building 356. Although individuals who use the parking lot outside this building

Table 8-3. Facility Area Monitoring.

TLD#	Location	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Average ± 2σ (95%)	Annual Dose ± 2σ (95%)
		mrem					
054-TLD2	NE of Bldg. 913B	45.3	16.5	15.5	52.6	32 ± 38	130 ± 151
054-TLD3	NW of Bldg. 913B	27.2	15.8	14.1	16.5	18 ± 12	74 ± 47
S6	Outside Former HWMF	31.4	31.0	30.6	23.9	29 ± 7	117 ± 28
088-TLD1	Former HWMF-50' East of S-6	38.7	39.1	38.4	29.6	36 ± 9	146 ± 36
088-TLD2	Former HWMF-50' West of S-6	46.7	44.2	44.0	30.0	41 ± 15	165 ± 59
088-TLD3	Former HWMF-100' West of S-6	39.8	38.5	41.1	29.2	37 ± 11	149 ± 42
088-TLD4	Former HWMF-150' West of S-6	25.6	22.2	23.6	21.0	23 ± 4	92 ± 16
075-TLD3	Bldg. 356	28.5	31.6	23.5	21.4	26 ± 9	105 ± 36
075-TLD5	North Corner of Bldg. 356	31.2	30.3	26.9	22.0	28 ± 8	110 ± 33

Notes:

HWMF = Hazardous Waste Management Facility

See Figure 8-1 for TLD locations.

could receive a dose from this source, the dose would be minimal due to the limited time an individual spends in the parking lot.

Two TLDs placed on the fence northeast and northwest of Building 913-B (AGS Tunnel Access) also showed higher than normal ambient external dose. 054-TLD2, located on the northeast side of Building 913-B, showed higher dose in both the first quarter (45.3 mrem or 453 μ Sv) and the fourth quarter (52.6 mrem or 526 μ Sv). However, the northwest TLD (054-TLD3) showed a higher dose only in the first quarter (27.2 mrem or 272 μ Sv). The potential cause of the higher doses is under investigation for this area.

8.2 DOSE MODELING

EPA regulates radiological emissions from DOE facilities under the requirements set forth in 40 CFR 61, Subpart H, *National Emission Standard of Radionuclides Other than Radon* (NESHAPs). This regulation specifies the compliance monitoring and requirements for reporting the radiation doses received by members of the public from airborne radionuclides. The regulation mandates that no member of the public shall receive a dose from DOE operations that is greater than 10 mrem (100 μ Sv) in a year. The emission monitoring requirements are set forth in Subpart H, Section 61.93(b) and include the use of a reference method for continuous monitoring

at major release points (defined as those with a potential to exceed 1 percent of the 10 mrem standard), and a periodic confirmatory measurement for all other release points. The regulations also require DOE facilities to submit an annual NESHAPs report to EPA that describes the major and minor emission sources and dose to the MEI. The dose estimates from various facilities are given in Table 8-4, and radiological emissions are discussed in more detail in Chapter 4.

As a part of the NESHAPs review process at BNL, any source that has the potential to emit radioactive materials is evaluated for regulatory compliance. Although the activities conducted under the Environmental Restoration (ER) Program are exempt under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), these activities are monitored and assessed for any potential to release radioactive materials, and to determine dose contribution, if any, to the environment. In 2004, a number of ER, Waste Management, and other activities were evaluated for compliance with NESHAPs regulations. EPA's approved dose modeling software was used in dose calculations (see Section 8.2.1 for details). Because this model was designed to treat all radioactive emission sources as continuous chronic emissions over the course of a year, it is not well suited for estimating short-term or acute releases. Consequently, it overestimates poten-

Table 8-4. MEI Effective Dose Equivalent from Facilities or Routine Processes.

Building No.	Facility or Process	Construction Permit No.	MEI Dose mrem (a)	Notes
348	Radiation Protection	None	6.55E-10	(b)
463	Biology Facility	None	ND	(b)
490	Medical Research	BNL-489-01	3.88E-08	(b)
490A	Energy and Environment National Security	None	8.40E-08	
491	Brookhaven Medical Research Reactor	None	1.53E-06	(c), (e)
510	Calorimeter Enclosure	BNL-689-01	ND	(f)
510A	Physics	None	ND	(b)
535	Instrumentation	None	4.62E-14	(b)
555	Chemistry Facility	None	ND	(b)
725	National Synchrotron Light Source	None	8.95E-11	(b)
750	High Flux Beam Reactor	None	2.55E-05	(c)
801	Target Processing Lab	None	3.02E-05	(b), (c)
802B	Evaporator Facility	BNL-288-01	NO	(e)
820	Accelerator Test Facility	BNL-589-01	ND	(d)
830	Environmental Science Department	None	ND	(d)
865	Reclamation Building	None	ND	(c)
906	Medical-Chemistry	None	ND	
925	Accelerator Department	None	2.87E-10	(b)
931	Brookhaven Linac Isotope Producer	None	4.39E-02	(c)
938	REF/NBTF	BNL-789-01	ND	(g)
942	Alternate Gradient Synchrotron Booster	BNL-188-01	ND	(h)
---	Relativistic Heavy Ion Collider	BNL-389-01	ND	(d)
Total Potential Dose from BNL Operations			4.402E-02	
EPA Limit			10.0 mrem	

Notes:

Diffuse, fugitive, and other sources are not included in this table since they are short term emissions.

MEI = Maximally Exposed Individual

NBTF = Neutron Beam Test Facility

REF = Radiation Effects Facility

(a) "Dose" in this table means effective dose equivalent to MEI.

(b) Dose is based on emissions calculated using 40 CFR 61, Appendix D methodology.

(c) Emissions are monitored at the facility.

(d) ND = No dose from emission source in 2004.

(e) NO = Not operational in 2004.

(f) This has become a zero-release facility since original permit application.

(g) This facility is no longer in use; it produces no radioactive emissions.

(h) Booster ventilation system prevents air release through continuous air recirculation.

tial dose contributions from short-term projects and area sources. For that reason, the results are considered to be "conservative"—that is, erring on the side of caution.

8.2.1 Dose Modeling Program

Compliance with NESHAPs regulations is demonstrated through the use of EPA software, the Clean Air Act Assessment Package-1988

(CAP88-PC), Version 2.1.1. This computer program uses a Gaussian plume model to estimate the average dispersion of radionuclides released from elevated stacks or diffuse sources. It calculates a final value of the projected dose at the specified distance from the release point by computing dispersed radionuclide concentrations in air, rate of deposition on ground surfaces, and intake via the food pathway (where

applicable). CAP88-PC calculates both the effective dose equivalent (EDE) to the MEI and the collective population dose within a 50-mile radius of the emission source. The CAP88-PC model provides conservative doses, in most cases. For purposes of modeling the dose to the MEI, all emission points are located at the center of the developed portion of the BNL site. The dose calculations are based on very low concentrations of the environmental releases and are based on chronic, continuous intakes in a year. The input parameters used in the model include radionuclide type, emission rate in curies (Ci) per year, stack parameters such as height and diameter, and emission exhaust velocity. Site-specific weather and population data are factored into the dose assessment. Weather data are supplied by measurements from BNL's meteorological tower, which includes wind speed, direction, frequency, and air temperature (see Chapter 1, Section 1.7). Population data used in the model are based on the Long Island Power Authority population survey (LIPA 1999). Because visiting researchers and their families may reside at the BNL on-site apartment area for extended periods of time, these residents are also included in the population file used for dose assessment.

8.2.2 Dose Calculation Methods and Pathways

8.2.2.1 Maximally Exposed Individual

The MEI is defined as a hypothetical person who resides at the site boundary and has a life-style such that no other member of the public could receive a higher dose. This person is assumed to reside 24 hours a day, 365 days a year at the BNL site boundary in the downwind direction, and to consume significant amounts of contaminated fish and deer based on projections from the New York State Department of Health (NYSDOH). In reality, it is highly unlikely that such a combination of "maximized dose" to any single individual would occur, but the concept is useful for evaluating maximum potential risk and dose.

8.2.2.2 Effective Dose Equivalent

The EDE to the MEI for low levels of radioactive materials dispersed into the environment

was calculated using the CAP88-PC, Version 2.1.1 dose model program. Site meteorology data were used to calculate annual dispersions for the midpoint of a given wind sector and distance. Facility-specific radionuclide release rates (Ci/year) were used for continuously monitored facilities. For small sources, the emissions were calculated using the method set forth in 40 CFR 61, Appendix D. The Gaussian dispersion model calculated the EDE at the site boundary and collective population dose values from immersion, inhalation, and ingestion pathways. These dose and risk calculations to the MEI are based on low emissions and chronic intakes.

8.2.2.3 Dose Calculation: Fish Ingestion

To calculate the EDE from the fish consumption pathway, the intake is estimated. Intake is the average amount of fish consumed by a person engaged in recreational fishing in the Peconic River, based on a NYSDOH study that estimated the consumption rate at approximately 15 pounds per year (NYSDOH 1996). For each radionuclide of concern for fish samples, the dry weight activity concentration was converted to picocuries per gram (pCi/g) wet weight, since "wet weight" is the form in which fish are caught and consumed. A dose conversion factor was used for each radionuclide to convert the activity concentration into the EDE. For example, the committed dose equivalent factor for cesium-137 (Cs-137) is $5.0\text{E-}02 \text{ rem}/\mu\text{Ci}$, as set forth in DOE/EH-0071. The dose was calculated as:

$$\text{dose (rem/year)} = \text{intake (kg/year)} \times \text{activity in flesh } (\mu\text{Ci/kg}) \times \text{dose factor (rem}/\mu\text{Ci})$$

8.2.2.4 Dose Calculation: Deer Meat Ingestion

The dose calculation for the deer meat ingestion pathway is similar to that for fish consumption. The Cs-137 radionuclide dose conversion factor was used to estimate dose for each radionuclide. The total pounds of deer meat ingested during the course of a year was 64 pounds (NYSDOH 1999), based on the U.S. Environmental Protection Agency Exposure Factors Handbook (EPA 1996).

8.3 DOSES FROM DIFFUSE, FUGITIVE, AND OTHER SOURCES

Diffuse sources are described as emissions of radioactive contaminants to the atmosphere that do not have a well-defined emission point such as a stack. Such sources are also known as non-point or area sources. Fugitive sources include releases to the air that are not released through an actively ventilated air stream (i.e., leaks from vents). The following potential radiological remediation/diffuse sources were evaluated in 2004 for their potential contribution to the overall BNL site dose.

8.3.1 Brookhaven Graphite Research Reactor Remediation

The Brookhaven Graphite Research Reactor (BGRR) decommissioning project continued through 2004. The Below Ground Duct (BGD), a part of the BGRR reactor's primary air cooling system, was constructed from steel-reinforced concrete. The BGD consists of two separate north and south ducts, which are connected to the BGRR exhaust air plenums. The duct sections upstream of the air coolers have a three-part thermal liner. Between the primary and secondary liners is a 3-inch space that forms the secondary air duct; the inner duct is the primary duct. The primary liner was constructed of 4 inches of crimped aluminum sheets sandwiched between two carbon-steel (inner and outer) binding plates. The BGD exhaust air filters were successfully removed in 2003 and the BGD primary liners were removed in 2004. Staff had previously collected and analyzed samples from the primary liner to identify and characterize the level of radiological contamination. The following radionuclides were identified in the primary liner: Am-241, Co-60, Cs-137, Pu-238, Pu-239, Pu-240, Sr-90, U-234, U-235, and U-238. These radionuclides have half-lives ranging from about 5 years to nearly 4.5 billion years (see Appendix C for half-life definition). Removal of the liners involved cutting the primary ducts using a remotely controlled robotic manipulator. All cut pieces were then containerized for off-site disposal.

In addition to the liner removal, the DOE Proposed Remedial Action Plan for 2004 in-

cluded the cleanup of contaminated soils adjacent to the BGRR and beneath the fuel storage canal, south secondary air system bustle, belowground expansion joint No. 4, cooler drain sump, and Building 701 north trench areas. The BGRR canal excavation and remediation plan included removing a portion of the canal, starting at the construction joint that is about 4 feet from column 7 of Building 701, and removing the east wall of the canal. The soils in the area were characterized and contamination was determined to be present from 10 feet below grade to about 24 feet below grade. The contaminated soils on the north, south, and east side of the canal were excavated to 4 feet below the canal. The volume of potentially contaminated soil from the canal was expected to be 443 yd³, with the highest concentrations of Cs-137 at 1,500 pCi/g and strontium-90 (Sr-90) at 572 pCi/g. Trace amounts of uranium-238 (U-238) and plutonium-239 (Pu-239) were also found during the soil characterization activities. Other radionuclide concentrations were very low and statistically close to the analytical minimum detection limits and therefore not included in the NESHAPs evaluation. About 40 yd³ of soil adjacent to the south secondary air system bustle were also removed, together with a 12-foot diameter caisson. As expected, the Cs-137 and Sr-90 soil concentrations near the air system bustle were the highest, at 89,000 pCi/g and 11,200 pCi/g, respectively. Other locations that were remediated are expansion joint No. 4 (6 yd³ of soil), the cooler drain sump (2 yd³ of soil), and the Building 701 north trench (2 yd³ of soil). The amount of soil estimated for removal was conservative; excavation activities continued until the cleanup goals were met or the slumping of soil prevented any further excavation. Clean soil was used to fill the excavated areas. The contaminated soil in these areas was removed to the extent possible based on field conditions, and to a maximum depth possible until the established cleanup concentration levels were reached: 67 pCi/g for Cs-137 and 15 pCi/g for Sr-90. These cleanup levels are based on EPA's 15-mrem (150 μ Sv) dose free-release criteria for unrestricted land use. The dose to the MEI from the BGRR canal and

deep soil removal operation was estimated to be $2.5\text{E-}08$ mrem ($2.5\text{E-}07$ μSv) in a year. An ambient air-sampling unit was set up in the downwind direction to ascertain if unplanned releases occurred and to quantify the airborne particulate activity during the soil removal process. The analytical results for particulate air filter samples were below the detection limits.

8.3.2 Alternating Gradient Synchrotron Snake Magnet Tritium Production

A NESHAPs compliance review was completed for possible tritium production in the liquid helium used to cool (“quench”) the Alternating Gradient Synchrotron (AGS) “snake magnets.” The potential for tritium production in the liquid helium is due to secondary and tertiary hadrons scattering and absorption interactions. For all three snake magnet cooling systems, only a small quantity (19.5 mCi) of tritium was estimated to be produced, even with the most conservative assumptions—such as using the highest value of helium cross section, independent spallation cross sections above 100 MeV energy, and similar interaction cross sections for all types of particles. The tritium saturation concentration in the AGS Ring was well below the derived air concentration (DAC). Consequently, any fugitive losses to the environment were insignificant.

Based on the conservative assumption that all the tritium produced in the magnet quench was released to the environment, a NESHAPs compliance dose estimate was done using EPA’s CAP88-PC dose modeling program. The dose modeling program calculated the EDE to the MEI in the southwest direction as $3.39\text{E-}8$ mrem ($3.4\text{E-}07$ μSv) in a year. This is well below the 0.1 mrem/year (1 μSv) limit that would require a NESHAPs permit and continuous monitoring of the emission source. A confirmatory air sample taken and analyzed for gamma-emitting radionuclides, in accordance with standard operating procedures, also showed that there were no emissions of any other radionuclide from the AGS Ring. The AGS facility was found to be in compliance with the NESHAPs regulations even when any potential fugitive loss of tritium from the snake magnet cryogenic cooling system was factored in.

8.3.3 NESHAPs Evaluations for Other Remediation Projects

8.3.3.1 Remediation of Building 650 Dust Collectors

Building 650 (Hot Laundry) was used from the late 1950s through the late 1960s to clean radioactive contaminants from clothes and equipment. The disposal system included a hopper with bag filters to collect sandblast grit and small particles that were emitted during the mechanical cleaning process. The decontamination and decommissioning work objective was to demolish the baghouse, stabilize or remove the facility equipment, and dispose of the waste at a licensed, off-site disposal facility. The planned operational sequence was to remove the highly contaminated components, remove or affix any loose surface contamination, survey and decontaminate the other components (as necessary), remove the filter bags, and remove the hopper. The radiological source term was developed through surveys and sampling. The radiological dose and risk assessment to the MEI was estimated to be $6.85\text{E-}05$ mrem ($6.9\text{E-}04$ μSv) in a year and would not require monitoring. Due to the presence of asbestos in the filter media and baghouse structures, work on this project was temporarily postponed in 2004 and will likely resume in 2005.

8.3.3.2 Sr-90 Remediation Systems

To remediate groundwater contaminated with Sr-90, a groundwater treatment system with five low-flow extraction wells was constructed in 2004. Two of the wells are located south and southeast of the Waste Concentration Facility (WCF), and three are located south of the BGRR area. Three drywells near Building 855 will be used to recharge the treated groundwater back to the aquifer. The Sr-90 treatment system includes a tray aeration system for removal of volatile organic compounds (VOCs), to be operated when necessary, with an oversized demister section to minimize the possibility of vapor releases, and an ion exchange, zeolite filtration system for Sr-90 removal. The well locations, screen intervals, and pumping rates were designed to avoid moving or capturing any existing tritium plumes from the g-2 and HFBR

tritium plume areas (see Chapter 7 for plume locations). A NESHAPs evaluation was completed to assess the potential dose to members of the public, because low concentrations of tritium were detected in the Geoprobe[®] characterization data. A conservative EDE estimate of $4.07\text{E-}09$ mrem ($4.1\text{E-}08$ μSv) in a year was calculated for the Sr-90 remediation system when it becomes operational in 2005.

8.3.3.3 Building 811 Remediation and Former HWMF Soil Removal

The remediation work at the WCF, also known as Building 811, consisted of transferring and stockpiling soil and debris (i.e., concrete, geotextile, wood, and asphalt) generated by the removal activities for the underground storage tanks at the building. Excavated contaminated soil was transferred from Building 811 to the railroad unloading area at the northeast boundary of the former HWMF, which was designated as the soil stockpile location. This location was selected because the soil there is already contaminated and will require remedial excavation to a depth of 1 ft. below grade. The site provides convenient access to the railroad spur so the soil can be loaded onto railcars for off-site disposal.

Residual soil contamination in the former HWMF area was also removed during the remediation project. The former HWMF had a permit under the Resource Conservation and Recovery Act (RCRA) for processing and storing hazardous and mixed waste generated at BNL. Radioactive waste was managed under DOE guidelines. The former HWMF is a fenced 12-acre controlled compound in Operational Unit (OU) I located in the southeastern part of the BNL site. All the facility's structures were removed in 2003, and approximately 1,200 yd³ of asphalt contaminated above the cleanup goal (67 pCi/g for Cs-137 and 15 pCi/g for Sr-90) were excavated and shipped off site for disposal.

The area contains a number of metal containment pits as well as concrete vaults and trenches that were used to store radioactive waste and sources. All stored waste materials have been removed and shipped off site for

disposal. At present, only building slabs and foundations remain in the area. These were decontaminated to levels below the soil cleanup goals. However, soils, vaults, and trenches remain to be remediated and shipped to an off-site waste facility. The former HWMF also had a shallow seasonal pond, known as the former HWMF wetland, along the fence bordering the western side. Approximately 25 yd³ of the sediment and surface soil in the wetland will be excavated and transported to an off-site disposal facility.

The remedial work radioactive source term for emission estimates was based on the concentration of radionuclides in the soil, concrete, external surface of the tanks, asphalt, and other structures. The EDE to the MEI from the remediation work at the former HWMF and Building 811 was estimated to be $3.31\text{E-}04$ mrem ($0.3\text{E-}03$ μSv) in a year in the southeast direction.

8.3.4 NESHAPs Evaluations at the Waste Management Facility

8.3.4.1 Waste Characterization Activities

BNL's Waste Management Program is responsible for collecting, characterizing, consolidating, and repackaging hazardous, mixed, and radioactive materials for shipment to off-site licensed disposal facilities. Building 865 is the primary facility for the handling of radioactive waste.

Before being shipped to a disposal facility, a 55-gallon drum that had been packed and sealed at Building 865 required visual inspection to ascertain if the six small containers inside it were intact. A paint-type container (No. A0172) was of primary concern because it contained 13.7 Ci of U-238 and 15 Ci of tritium, in the form of uranium hydride. If this container had been breached, there was the potential to release tritium gas. A NESHAPs evaluation was completed for the drum, based on worst-case assumptions that radioactivity from the tritium and uranium source would become airborne during inspection. The EDE to the MEI at the southeast location was estimated to be $1.11\text{E-}05$ mrem ($1.1\text{E-}04$ μSv) in a year. Nevertheless, the large drum was opened in Building 801's Room

67, the Hot Cell, which is specially designed for radiological work of this type.

8.3.4.2 Risk Analysis Scenario: Disposal of Neutron Source

The possibility of significant radiological dose from a mixed, compact, sealed neutron source was evaluated using an unlikely scenario, for assurance purposes. In this scenario, a 50-Ci americium-beryllium neutron source [$^{241}\text{Am}-\text{Be}(\alpha, n)$] was acquired from Nuclear Materials and Equipment Corporation in 1965. The source activity after decay correction was calculated to be approximately 47 Ci. The sealed neutron source had a cylindrical shape and was doubly encapsulated in a tantalum inner container (0.050 in. thick) and stainless steel outer container (0.040 in. thick).

In the risk analysis, inhalation of the Am-241 radionuclide was considered most likely, so this pathway was used for the dose risk assessment. To estimate the potential airborne concentration, it was assumed that the neutron source's integrity was breached due to a strong mechanical force that subsequently spread the contamination in the building, leading to inhalation, with dose consequences to the worker and members of the public. Since the neutron source was solid, a conservative assumption was made that approximately $1\text{E}-06$ fractions of activity would contaminate the surface area. Therefore, the spread source activity on the building surface inside would be $4.7\text{E}-05$ Ci. It was also assumed that about 10 percent of the total surface area would be contaminated by the release of the Am-241 radionuclide. The total surface area that potentially could be contaminated was 13.72×28.04 m; therefore, the 10 percent surface area contaminated was estimated to be approximately 38.5 m².

Another parameter that is very important in dose estimation is the resuspension factor (RF), which is the ratio of the airborne concentration of a contaminant to the surface concentration of the contaminant. The RF is a highly sensitive parameter that would greatly influence the inhalation dose calculation. The RF would be affected by many physical factors, such as the type and intensity of physical (mechanical) ac-

tion on the sealed source, nature of the surface contamination, particle size, particle distribution, surface chemistry, and any filtration mechanisms already in place. Another possible factor is the role of a ventilation system, which was assumed to be "off" for purposes of the risk analysis scenario. The effects of the entire list of possible variables were not evaluated in the dose risk assessment; a very simplistic, straightforward model was adopted.

It was assumed that 1 percent of the source radionuclide activity would be released into the environment through the stack in the building. The total volume of the release was estimated to be $5.38\text{E}3$ m³ ($3,200$ ft³/min $\times$ 60 minutes $\times$ 0.028 m³/ft³). Based on these assumptions, the total activity that would be released from the building was calculated to be 933 μCi . Therefore, the MEI residing 2,500 meters in the southeast direction would receive an EDE of < 0.1 mrem (1 μSv) in a year.

8.3.4.3 Tritium-Containing Bottles

Because there are no economically viable and technically feasible treatment methods available for tritium gas, a NESHAPs compliance review was completed for two small tritium-containing bottles that were to be vented via stack No. 105 in the Building 865 hood. The total volume released from the two bottles was 6.25 ft³. The tritium activity in the first bottle was 20 mCi in 1996. Tritium activity in the second bottle was 0.5 μCi , as of 1998. Although decay correction would yield a lower quantity of tritium, these original activity levels were used as the basis for the airborne source term. According to the radiological dose risk assessment calculations, the tritium-containing bottles would yield an EDE to the MEI of $1.49\text{E}-11$ mrem ($1.5\text{E}-10$ μSv) in a year.

8.3.5 NESHAPs Evaluations for Activation Sources

8.3.5.1 Former Source Development Laboratory

A NESHAPs compliance review was completed for the Source Development Laboratory, now known as the Deep Ultra Violet-Free Electron Laser (DUV-FEL), to update the Safety Assessment Document. There was a potential for air activation in the 4-inch air gap

due to bremsstrahlung radiation. The saturation activities of short-lived radionuclides nitrogen-13 (N-13) and oxygen-15 (O-15) were 8.5 μCi and 0.9 μCi , respectively. Consequently, the dose contribution to members of the public would be insignificant. The production of ozone gas was also estimated. The result was 4.2E-5 ppm for a 12-hour irradiation, which is well below the threshold limit for ozone of 0.1 mg/L. Therefore, the potential risk from ozone production was also miniscule.

8.3.5.2 *National Synchrotron Light Source*

During operation of the National Synchrotron Light Source (NSLS, Building 725), induced activity in air can be created by beam losses occurring during injection or routine operations. The induced activity is primarily created from high-energy photon or neutron interactions with nitrogen or oxygen atoms in the air, creating short-lived positron emitters such as carbon-11 (C-11), N-13, or O-15. In high-intensity and high-energy machines, these radionuclides can reach significant levels and require engineering or administrative controls to reduce exposure to personnel and releases into the environment. The potential for air activation was considered for two NSLS occurrences: 1) the beam transported to the x-ray or VUV injection line beam dumps, and 2) loss of stored beam in the x-ray ring. The operations and enclosures described below are located on the first floor in Building 725.

The saturation concentrations within the booster enclosure have previously been determined at 0.025 percent of the DAC for occupational workers. Therefore, it can be reasonably concluded that the dose to members of the public would be negligible. However, an environmental risk assessment was necessary for any fugitive emissions that could contribute to dose when emissions are outside of the accelerator enclosure. The fugitive emissions were evaluated to demonstrate compliance with EPA's annual limit of 10 mrem (100 μSv) to the members of the public from DOE facilities' operations. The total dose to the MEI resulting from the activation of air due to NSLS operations was estimated to be 1.12E-08 mrem (1.2E-07 μSv) in a year. Therefore, the dose and risk to the mem-

bers of the public would be minimal. An annual administrative review of the facility is sufficient to evaluate any changes in operations, process, beam intensity, or any other contributing factor that may increase emissions to the environment.

8.4 DOSE FROM POINT SOURCES

8.4.1 *Brookhaven Linac Isotope Producer*

Source term descriptions for point sources are given in Chapter 4; however, an update on emissions from the Brookhaven Linac Isotope Producer (BLIP) is appropriate here because the BLIP is the only emission source with any potential to contribute dose to members of the public greater than 1 percent of the DOE limit. The BLIP facility uses the excess beam capacity of the Linear Accelerator (Linac) to produce short-lived radioisotopes for medical diagnostic procedures, medical imaging, and scientific research. During the irradiation process, the targets are cooled continuously by recirculating water in a 16-inch-diameter shaft. The principal gaseous radionuclides produced as a result of activation of the cooling water are O-15 and C-11. Because the BLIP facility is considered a major emission source, the facility emissions are directly measured using a low-resolution gamma spectrometer with an in-line sampling system connected to the air exhaust. This measures the short-lived gaseous products that cannot be sampled and analyzed by conventional methods. Particulates and radioiodines are monitored with filter paper and granular activated charcoal, which are exchanged weekly for laboratory analysis. The tritium sampler also operates continuously, with weekly sample collection and analyses.

In 2004, the BLIP facility operated over a period of 11 weeks. During the year, 680 Ci of C-11 and 2,027 Ci of O-15 were released from the BLIP facility. Tritiated water vapor from activation of the targets' cooling water was also released, 7.32E-02 Ci. The EDE to the MEI was calculated to be 4.39E-02 mrem (0.44 μSv) in a year from BLIP operations.

In 2004, the total emissions from the facility decreased in comparison to the previous two years, and an objective to further reduce emissions is being pursued for the BLIP facility. Since moisture is the primary source of emis-

sions (humidity from the Hot Cell's cooling water), a shroud enclosure was installed to enclose the cooling water surface (16-in.-diameter shaft), target holder transfer cases, chain drive assembly (including motor supports), and other associated accessories. This engineering control was expected to significantly reduce (by > 28 percent) the gaseous emissions from the BLIP facility. The efficiency test of the shroud seal was not satisfactorily completed in 2004 because of the short runtime (11 weeks) and lower beam energy irradiation of the targets. However, preliminary data show that the emissions reduction should be greater than 30 percent.

8.4.2 Brookhaven Medical Research Reactor

In January 2003, the fuel elements from the decommissioned Brookhaven Medical Research Reactor (BMRR) were shipped off site, greatly reducing any potential for radioactive emissions from the facility. The semiannual particulate and charcoal air sampling data showed no quantifiable radioactive emissions from the BMRR. In September 2003, BNL initiated a request for approval from EPA to stop monitoring emissions at the BMRR. However, EPA requested clarification of the sampling data submitted and also required an additional round of sampling before making a final determination to eliminate BMRR emissions sampling. During 2004, the semiannual sampling of the BMRR continued and the results confirmed that there were no radionuclides present with the exception of naturally occurring potassium-40 (K-40), at 164 ± 35 pCi per filter. Although there was no airborne environmental pathway for tritium emissions, as all the vents from the reactor vessel are sealed, a dose estimate was completed for the evaporative loss of tritium. The dose risk to the MEI from tritium was estimated to be $7.42\text{E-}08$ mrem ($7.4\text{E-}07$ μSv) in a year.

8.4.3 Unplanned Releases

There were no unplanned releases in 2004.

8.5 DOSE FROM INGESTION

Deer and fish bioaccumulate radionuclides in their tissues and organs, and therefore samples are analyzed to evaluate the dose contribu-

tion to humans from the ingestion pathway. As discussed in Chapter 6, deer meat samples collected off site and less than 1 mile from the BNL boundary were used to assess the potential dose impact to the MEI. Eleven samples of deer meat (flesh) were used to calculate the "off site and less than 1 mile" averages for the purpose of dose calculations. K-40 and Cs-137 were the two radionuclides detected in the tissue samples. K-40 is a naturally occurring radionuclide and is not related to BNL operations. The average K-40 concentrations were 3.6 ± 1.1 pCi/g (wet weight) in the flesh and 2.7 ± 0.8 pCi/g (wet weight) in the liver. The average Cs-137 concentrations were 0.9 ± 0.3 pCi/g (wet weight) in the flesh and 0.4 ± 0.1 pCi/g (wet weight) in the liver (average for the "off site and less than 1 mile" as shown in Table 6-2). The potential dose from consuming deer meat with the average Cs-137 concentration was estimated as 1.31 mrem (13.1 μSv) in a year. This is about 13 percent of the health advisory limit of 10 mrem (100 μSv) established by NYSDOH.

In collaboration with the New York State Department of Environmental Conservation (NYSDEC) Fisheries Division, BNL maintains an ongoing program of collecting and analyzing fish from the Peconic River and surrounding freshwater bodies. In 2004, the pumpkinseed samples collected by NYSDOC in the Peconic River on the BNL site had the highest concentration (1.05 pCi/g) of Cs-137, so this value was used to estimate the EDE to the MEI (assuming consumption of 15 pounds of fish). The potential dose from consuming fish was estimated at 0.37 mrem (3.7 μSv) in a year. It is highly unlikely that an individual would consume fish with the highest concentration from this location, but these data were used to estimate potential maximum dose as a worst-case scenario for the MEI.

8.6 DOSE TO AQUATIC AND TERRESTRIAL BIOTA

DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, provides the guidelines for screening methods to estimate radiological doses to aquatic animals, terrestrial plants, and

Table 8-5. BNL Site Dose Summary.

Pathway	Dose to Maximally Exposed Individual	Percent of DOE 100 mrem/year Limit	Estimated Population Dose per year
Inhalation			
Air	0.044 mrem (0.44 μ Sv)	<1%	0.16 person-rem
Ingestion			
Drinking water	None	None	None
Fish	0.37 mrem (3.7 μ Sv)	<1%	Not tracked
Deer Meat	1.31 mrem (13.1 μ Sv)	<2%	Not tracked
All Pathways	1.72 mrem (17.2 μSv)	<2%	0.16 person-rem

terrestrial animals using environmental surveillance data. The RESRAD-BIOTA 1.0 biota dose screening program was used to evaluate compliance with the requirements for protection of biota specified in DOE Order 5400.5 (1990), *Radiation Protection of the Public and the Environment*, and proposed Rule 10 CFR 834, Subpart F (66 FR 25380). The terrestrial animal and plant doses were evaluated based on 0.56 pCi/L of Sr-90 in surface waters at the HE sampling location on the Peconic River (see Figure 5-8 for sample station locations). Soil samples collected at location P4 had concentrations of Sr-90 of 0.18 pCi/g. The dose to terrestrial animals was calculated to be 6.09E-06 Gy/day and 1.10E-06 Gy/day to terrestrial plants. The doses to terrestrial animals and plants were well below the biota dose limit of 1 mGy/day.

For calculating dose to aquatic animals, values from Swan Pond were used because both the surface water and sediment samples came from the same location. The Cs-137 sediment concentration was 460 pCi/kg, and Sr-90 concentration in surface water was 0.78 pCi/L. The aquatic animal dose was estimated to be 2.38E-07 Gy/day; to riparian animals, the estimated dose was 2.93E-06 Gy/day. Therefore, the dose to aquatic and riparian animals was also well below the 10-mGy/day limit specified by the regulations.

8.7 CUMULATIVE DOSE

Table 8-5 summarizes the potential cumulative dose from the BNL site. The total dose to the MEI from air and ingestion pathways was estimated to be 1.72 mrem (17.2 μ Sv), as shown

in Table 8-5. In comparison, the EPA regulatory limit for the air pathway is 10 mrem (100 μ Sv) and the DOE limit from all pathways is 100 mrem (1,000 μ Sv). The effective dose was well below the DOE and EPA regulatory limits, and the ambient TLD dose was within normal background levels seen at the BNL site. The potential dose from drinking water was not estimated, because most of the residents adjacent to the BNL site get their drinking water from the Suffolk County Water Authority and not private wells.

To put the potential dose impact into perspective, a comparison was made with other sources of radiation. The annual dose from all natural background sources and radon is approximately 300 mrem (3000 μ Sv). A diagnostic chest x-ray would result in 5 to 20 mrem (50-200 μ Sv) per exposure. Using natural gas in homes yields about 9 mrem (90 μ Sv) per year, cosmic radiation yields 26 mrem (260 μ Sv), and natural potassium in the body yields approximately 39 mrem (390 μ Sv) of internal dose. Even with conservative estimates of dose from the air pathway and ingestion of local deer meat and fish, the cumulative dose from BNL operations in 2004 was well below the dose that could be received from a single chest x-ray.

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Quality Assurance

Quality assurance is an integral part of every activity at BNL. A comprehensive Quality Assurance/Quality Control (QA/QC) Program is in place to ensure that all environmental monitoring samples are representative and that data are reliable and defensible. QC 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 being used to support decision making.

In 2004, BNL used the on-site Analytical Services Laboratory (ASL) and five off-site contract 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 ASL ceased performing analyses in January of 2004. For the remainder of the year, all samples were sent to off-site analytical laboratories.

The multilayered components of QA monitored at BNL ensure that all analytical data reported for the 2004 Site Environmental Report are reliable and of high quality.

9.1 QUALITY PROGRAM ELEMENTS

As required by DOE Order 450.1, *Environmental Protection Program*, BNL has established a QA/QC Program to ensure that the accuracy, precision, and reliability of environmental monitoring data are consistent with the requirements of 10 CFR 830, Subpart A, *Quality Assurance Requirements* and DOE Order 414.1A, *Quality Assurance*. The responsibility for quality at BNL starts with the Laboratory director, who approves the policies and standards of performance governing work, and extends throughout the entire organization. The purpose of the BNL Quality Management (QM) System is to implement QM methodology throughout the various BNL management systems and associated processes, in order to:

- Plan and perform BNL operations in a reliable and effective manner to minimize any impact on the health and safety of the public, employees, and the environment
- Standardize processes and support continual improvement in all aspects of BNL operations

- Enable the delivery of products and services that meet customers' requirements and expectations

For environmental monitoring, QA is deployed as an integrated system of management activities. These activities involve planning, implementation, control, reporting, assessment, and continual improvement. QC activities measure each process or service against the QA standards. QA/QC practices and procedures are documented in detail in manuals, plans, and a comprehensive set of standard operating procedures (SOPs) for environmental monitoring (EM-SOPs). Staff members who must follow these procedures are required to document that they have reviewed and understand them.

The ultimate goal of the environmental monitoring and analysis QA/QC program is to ensure that results are representative and defensible, and that data are of the type and quality needed to verify protection of the public, employees, and the environment. Figure 9-1 depicts the flow of the QA/QC elements of BNL's

Environmental Monitoring Program and indicates the sections of this chapter that discuss each element in more detail.

BNL environmental personnel determine sampling requirements using the EPA Data Quality Objective (DQO) process or its equivalent. During this process, the project manager for each environmental program determines the type, amount, and quality of data needed to support decision making, legal requirements, and stakeholder concerns. An environmental monitoring plan or project-specific sampling plan is then prepared, specifying the location, frequency, type of sample, analytical methods to be used, and a sampling schedule. These plans or the EM-SOPs also specify data acceptance criteria. Contracts with off-site analytical laboratories are established. Detailed EM-SOPs direct sampling technicians on proper sample collection, preservation, and handling requirements. Field QC samples are prepared as necessary. Samples are analyzed in the field or at certified laboratories in accordance with EM-SOPs. The results are then validated or verified in accordance with published procedures. Finally, data are reviewed and evaluated by environmental professionals and management in the context of expected results, related monitoring results, historical data, and applicable regulatory requirements (e.g., drinking water standards, permit limits, etc.). Data are then used to support decision making. Data are also reported as required and summarized in this annual report.

9.2 SAMPLE COLLECTION AND HANDLING

In 2004, environmental monitoring samples were collected as specified by EM-SOPs, the *BNL Environmental Monitoring Plan Update January 2004* (BNL 2004a), and project-specific work plans, as applicable. For example, the *BNL Groundwater Monitoring Program Quality Assurance Project Plan (QAPP)* (BNL 1999a) describes the QA program and QC requirements that must be followed for groundwater monitoring. This plan documents organizational structure, documentation requirements, sampling requirements, field QA/QC sample collection, acceptance criteria, sample custody

requirements, data validation procedures, and general data handling and database procedures.

BNL has sampling procedures for all environmental media, including groundwater, surface water, soil, sediment, air, flora, and fauna. These procedures contain detailed information on how to prepare for sample collection; what type of field equipment to use and how to calibrate it; how to properly collect, handle, and preserve samples; and how to manage any wastes generated during sampling. The procedures ensure consistency between samples collected by BNL sampling personnel and samples collected by outside contractors in support of the environmental restoration, compliance, and surveillance programs.

QC checks of sampling processes include the collection of field duplicates, matrix spike samples, field blanks, trip blanks, and equipment blanks. For example, field readings of water quality parameters are taken until all parameters are within acceptable limits when sampling groundwater. Also, specific sampling methodologies include QC checks. An example of this is the low-flow groundwater sampling technique, which includes checks to ensure that monitoring wells are properly purged before readings are taken.

All wastes generated during sampling (contaminated equipment, purge water from wells, etc.) are managed in accordance with applicable requirements. One factor considered during sample collection is minimizing the amount of waste generated, consistent with the Pollution Prevention Program described in Chapter 2.

9.2.1 Field Sample Handling

To ensure the integrity of samples, chain-of-custody (COC) was maintained and documented for all samples collected in 2004. A sample is considered to be in the custody of a person if any of the following rules of custody are met: 1) the person has physical possession of the sample, 2) the sample remains in view of the person during possession, 3) the sample is placed in a secure location by the custody holder, or 4) the sample is in a designated secure area. These procedures are outlined in EM-SOP 109, "Chain-of-Custody Procedure" (BNL 2003).

Figure 9-1. Flow of Environmental Monitoring QA/QC Program Elements.

methylmercury, samples are cooled immediately and shipped to the analytical laboratory on the day of collection. After samples arrive at the analytical laboratory, they are preserved with hydrochloric acid.

Sample preservation is maintained as required throughout shipping. If samples are sent via commercial carrier, a bill-of-lading is used. COC seals are placed on the shipping containers; their intact status upon receipt indicates that custody was maintained during shipment.

9.2.2 Field Quality Control Samples

Field QC samples collected for the environmental monitoring program include equipment blanks, trip blanks, field blanks, field duplicate samples, and matrix spike/matrix spike duplicate samples. The rationale for selecting specific field QC samples and minimum requirements for their use in the environmental monitoring program are provided in EM-SOP 200, "Collection and Frequency of Field Quality Control Samples" (BNL 2004b) series, which addresses the collection and frequency of field QC samples. Equipment blanks and trip blanks (see below) were collected for all appropriate media in 2004.

An **equipment blank** is a volume of water (in this case, laboratory-grade water) that is used to rinse a sampling tool after decontamination. The rinse water is collected and tested to verify that the sampling tool is not contaminated. Equipment blank samples are collected, as needed, to verify the effectiveness of the decontamination procedures on non-dedicated or reusable sampling equipment.

A **trip blank** is provided with each shipping container of samples to be analyzed for volatile organic compounds (VOCs). Analysis of trip blanks show whether a sample bottle was contaminated during shipment from the manufacturer, while in bottle storage, in shipment to the laboratory, or during analysis at a lab. Trip blanks consist of an aliquot of laboratory-grade water sealed in a sample bottle, usually prepared by the analytical laboratory prior to shipping the sample bottles to BNL. If trip blanks were not provided by the contract laboratories, then field sampling technicians prepare trip blanks before they collect the samples. Trip blanks were

included with all shipments of aqueous samples for VOCs analyses in 2004.

Field blanks are collected to check for cross-contamination that might occur during sample collection. For the groundwater monitoring program, one field blank is collected for every 20 samples, or one per sampling round, whichever is more frequent. Field blanks are analyzed for the same parameters as the groundwater samples. For other programs, the frequency of field blank collection is based on their specific DQOs.

In 2004 (as in other years), the most common contaminants detected in the trip, field, and equipment blanks were methylene chloride, acetone, and chloroform. These compounds are commonly detected in blanks and do not pose significant problems with the reliability of the analytical results. Several other compounds were also detected, such as toluene and strontium-90 (Sr-90), at low levels. When these contaminants are detected, validation or verification procedures are used, where applicable, to qualify the associated data as "nondetects," as described in the 200 Series of BNL EM-SOPs (see Section 9.4). The results from blank samples collected during 2004 did not indicate any significant impact on the quality of the results.

Field duplicate samples are analyzed to check the reproducibility of sampling and analytical results, based on EPA Region II guidelines (EPA 2001). For example, in the groundwater monitoring program, duplicates are collected for 5 percent of the total number of samples collected for a project per sampling round. During 2004, 83 duplicate samples were collected for nonradiological analyses, and 75 duplicate samples were collected for radiological analyses. All duplicate samples were acceptable for input into BNL's Environmental Information Management System (EIMS) database, which is used to manage the Laboratory's environmental data. Duplicates were analyzed only for the parameters relevant to the program they monitored. Of the 5,439 nonradiological parameters analyzed in 2004, 99.98 percent of the analyses met QA criteria. Of the 365 radiological parameters monitored, 98 percent met QA criteria. These results indicate consistency between the laboratory and field sampling technicians.

Matrix spike and matrix spike duplicates are performed to determine whether the sample matrix (e.g., water, soil, air, vegetation, bone) adversely affected the sample analysis. A *spike* is a known amount of analyte added to a sample. Matrix spikes are performed at a rate specified by each environmental program's DQOs. The rate is typically one per 20 samples collected per project. No significant matrix effects were observed in 2004 for routine matrices such as water and soil. Nonroutine matrices, such as oil, exhibited expected matrix issues.

9.2.3 Tracking and Data Management

Most environmental monitoring samples and analytical results were tracked in the EIMS. The small number of environmental samples that were not tracked in the EIMS were from Chemtex Environmental Laboratory, which cannot produce the electronic data deliverables needed to enter the data into the EIMS. Tracking was initiated when a sample was recorded on a chain-of-custody form. Copies of the COC form and supplemental forms were provided to the project manager or the sample coordinator and forwarded to the data coordinator to be entered into the EIMS. Each analytical laboratory also maintained its own internal sample tracking system.

Following sample analysis, the contract laboratory provided the results to the project manager or designee and, when applicable, to the validation subcontractor, in accordance with their contract. Once results of the analyses were entered into the EIMS, reports could be generated by project personnel and DOE Brookhaven Area Office staff using a web-based data query tool.

9.3 SAMPLE ANALYSIS

In 2004, environmental samples were analyzed either by the on-site analytical laboratory or by one of five contract laboratories, whose selection is discussed in Section 9.3.1. All samples were analyzed according to EPA-approved methods, where such methods exist, and by standard industry methods where there are no EPA methods. In addition, field sampling technicians performed field monitoring

for parameters such as conductivity, dissolved oxygen, pH, temperature, and turbidity.

9.3.1 Qualifications

BNL used the following laboratories for analysis of environmental samples in 2004:

- BNL Analytical Services Laboratory for radiological analytes (January only)
- General Engineering Laboratories, LLC (GEL) in Charleston, South Carolina, for radiological and nonradiological analytes
- H2M Labs, Inc. (H2M) in Melville, New York, for nonradiological analytes
- Severn-Trent Laboratories, Inc. (STL) based in St. Louis, Missouri, for radiological and nonradiological analytes
- Chemtex Environmental Laboratory, Inc. in Port Arthur, Texas, for select nonradiological analytes
- Brooks Rand, LLC in Seattle, Washington, for mercury and methylmercury analyses

The process of selecting off-site contract laboratories involves a number of factors: 1) their record on performance evaluation (PE) tests, 2) their contract with the DOE Integrated Contract Procurement Team, 3) pre-selection bidding, and 4) their adherence to their own QA/QC programs, which must be documented and provided to BNL. Routine QC procedures that laboratories must follow, as discussed in Section 9.5, include daily instrument calibrations, efficiency and background checks, and standard tests for precision and accuracy. All the analytical laboratories that BNL used in 2004 were certified by the New York State Department of Health (NYSDOH) for the relevant analytes, where such certification existed. The laboratories also were subject to PE testing (see Section 9.7) and DOE-sponsored audits.

9.4 VERIFICATION AND VALIDATION OF ANALYTICAL RESULTS

Environmental monitoring data are subject to data verification and, in certain cases, data validation, when the data quality objectives of the project require this step. For example, as per the *BNL Groundwater Monitoring Program Quality Assurance Project Plan* (BNL 1999b), a significant portion of the groundwater sam-

ples analyzed for environmental restoration projects underwent data validation in addition to verification.

The data verification process involves checking for common errors associated with analytical data. The following criteria can cause data to be rejected during the data verification process:

- *Holding time missed* – The analysis is not initiated or the sample is not extracted within the time frame required by EPA or by the contract.
- *Incorrect test method* – The analysis is not performed according to a method required by the contract.
- *Poor recovery* – The compounds or radioisotopes added to the sample (spiked) before laboratory processing are not recovered at the recovery ratio required by the contract.
- *Insufficient QA/QC data* – Supporting data received from the analytical laboratory are insufficient to allow validation of results.
- *Incorrect minimum detection limit (MDL)*. The laboratory reports extremely low levels of analytes as “less than minimum detectable,” but the contractually required limit is not used.
- *Invalid chain-of-custody* – There is a failure to maintain proper custody of samples, as documented on COC forms.
- *Instrument failure* – The instrument does not perform correctly.
- *Preservation requirements not met* – The requirements identified by the specific analytical method are not met or properly documented.
- *Contamination of samples from outside sources* – These possible sources include sampling equipment, personnel, and the analytical laboratory itself.
- *Matrix interference* – Analysis is affected by dissolved inorganic/organic materials in the matrix.

Data validation is a more extensive process than data verification. Validation includes all the verification checks as well as checks for less common errors, including instrument calibration that was not conducted as required,

internal analyte standard errors, transcription errors, and calculation errors. The amount of data checked varies, depending on the environmental media and on the data quality objectives for each project. Data for some projects, such as long-term groundwater monitoring, may require only verification. Data from initial investigations receive the more rigorous validation testing, performed on 20 to 100 percent of the analytical results. The results of the verification or validation process are entered into the EIMS.

9.4.1 Verifying and Validating ASL Results

For samples analyzed by BNL’s Analytical Services Laboratory in 2004, the QA officer or group leader verified that all analytical batches fulfilled internal QA/QC acceptance criteria. These criteria included precision, accuracy, recovery, instrument background checks, and stable instrument efficiency performance. All QA/QC data were reviewed before ASL results were reported.

9.4.2 Checking Off-Site Results

Nonradiological data analyzed off site in 2004 were verified and validated using BNL EM-SOPs in the 200 Series and EPA contract laboratory program guidelines (EPA 1992, 2001). Radiological packages were verified and validated using BNL and DOE guidance documents (BNL 2002, DOE 1994). During 2004, the verifications were conducted using a combination of manually checking the hard copy data packages and the use of a computer program developed at BNL to verify the information reported electronically and stored in the EIMS.

9.5 ANALYTICAL LAB QA/QC

In 2004, sample results for environmental restoration, compliance, and surveillance were analyzed by ASL or by one of the off-site contract laboratories. Procedures for calibrating instruments, analyzing samples, and assessing QC were consistent with EPA methodology. QC checks that were performed included analyzing blanks and instrument background; using Amersham Radiopharmaceutical Company or National Institute for Standards and Technology (NIST) traceable standards; and analyzing

reference standards, spiked samples, and duplicate samples. BNL's contracts with the off-site laboratories specify analytes, required methods, detection limits, and data deliverables—which include standard batch QA/QC performance checks. As part of the contract laboratory selection process, candidate laboratories are required to provide BNL with copies of their QA/QC manuals, as well as their QA program plans.

When discrepancies were found in field sampling designs, documented procedures, COC forms, data analyses, data processing systems, QA software, or when failures in PE testing occurred, nonconformance reports were generated. Following investigation into the root causes, corrective actions were taken by the analytical laboratory and tracked to closure.

9.6 PERFORMANCE OR PROFICIENCY EVALUATIONS

Four of the contract laboratories (GEL, STL, H2M, and Brooks Rand, LLC) participated in several national and state PE testing programs in 2004. The fifth contractor, Chemtex Environmental Laboratory, Inc. did not participate in PE testing because there is no testing program for the specific analytes analyzed: tolyltriazole, polypropylene glycol monobutyl ether, and 1,1-hydroxyethylidene diphosphonic acid. Each of the participating laboratories took part in at least one testing program, and several laboratories participated in multiple programs. Results of the tests provide information on the quality of a laboratory's analytical capabilities. The testing was conducted by Environmental Resource Associates (ERA), the National Voluntary Laboratory Accreditation Program, the DOE Environmental Measurements Laboratory (EML) Quality Assessment Program, the voluntary Mixed Analyte Performance Evaluation Program (MAPEP), NYSDOH Environmental Laboratory Accreditation Program (ELAP), and the Analytical Products Group (APG). The results from these tests are summarized in Section 9.6.1. Because Brooks Rand, LLC only analyzed samples for mercury and methylmercury, their PE results are not summarized. Also, because ASL was closed as of February 2004,

their PE results are unavailable. Brooks Rand, LLC and ASL maintained the required certification during the periods in 2004 when they performed analyses for BNL.

9.6.1 Summary of Test Results

In Figures 9-2 and 9-3, results are plotted as percentage scores that were “Acceptable,” “Warning (But Acceptable),” or “Not Acceptable.” A Warning (But Acceptable) is considered by the testing organization to be “satisfactory.” An “average overall satisfactory” score is the sum of results rated as Acceptable and those rated as Warning (But Acceptable), divided by the total number of results reported. A Not Acceptable rating reflects a result that is greater than three standard deviations from the known value—a criterion set by the independent testing organizations, rather than BNL.

Figure 9-2 summarizes radiological performance scores in the DOE (EML), ERA, and MAPEP programs. During 2004, the NYS ELAP did not provide radiological samples for PE testing, so there were no ELAP scores as there have been in past years. GEL and STL had average overall satisfactory scores of 96 and 87 percent, respectively. More details about the radiological assessments are in Section 9.6.2.1.

Figure 9-3 summarizes the three participating laboratories' (GEL, H2M, and STL) non-radiological performance results in the ERA, MAPEP, and ELAP tests. For nonradiological tests, the average overall satisfactory results ranged from 94.2 to 97.9 percent. Additional details on nonradiological evaluations are in Section 9.6.2.2.

The contract laboratories received an acceptable rating for a combined average overall satisfactory score of 93.9 percent on the radiological and nonradiological PE tests performed in 2004.

9.6.1.1 Radiological Assessments

In 2004, STL participated in the DOE EML Quality Assessment Program, the ERA radiological program, and the MAPEP evaluations of mixed analytes. GEL participated in the ERA and MAPEP programs. The NYSDOH ELAP provided no samples for radiological testing in 2004.

Note that the Acceptable scores and the Warning (But Acceptable) scores combined constitute the “overall satisfactory” category referred to in the text of this chapter.

Figure 9-2. Summary of Scores in the Radiological Proficiency Evaluation Programs.

Note that the Acceptable scores and the Warning (But Acceptable) scores combined constitute the “overall satisfactory” category referred to in the text of this chapter.

Figure 9-3. Summary of Scores in the Nonradiological Proficiency Evaluation Programs.

Of STL's radiological tests on samples of air, vegetation, water, and soil, 82.9 percent were within the testing organization's acceptable range. Both GEL and STL participated in the ERA radiological PE studies: 100 percent of GEL's tests on radiological samples were in the acceptable range; 86.9 percent of STL's tests were acceptable. Both GEL and STL participated in the MAPEP evaluations: 92 percent of GEL's tests on radiological samples were in the acceptable range, as were 91.4 percent of STL's tests.

9.6.1.2 Nonradiological Assessments

During 2004, H2M participated in the NYSDOH ELAP evaluations of performance on tests of nonpotable water, potable water, and solid wastes. NYSDOH found 97.3 percent of H2M's nonradiological tests to be in the acceptable range. GEL and STL, which are certified through the National Environmental Laboratory Accreditation Conference (NELAC), were not required to participate in ELAP evaluations.

STL and GEL voluntarily participated in the ERA water supply and water pollution studies, although this evaluation is not required for New York State certification. ERA found that 97.5 percent of GEL's tests were in the acceptable range, as were 95.1 percent of STL's tests.

GEL and STL also voluntarily participated in MAPEP evaluations. These evaluations showed that 97.5 percent of GEL's nonradiological tests were in the acceptable range, as were 97.9 percent of STL's tests.

9.7 AUDITS

As part of DOE's Integrated Contract Procurement Team Program, STL and GEL were audited during 2004 (DOE 2004a, b). During the audits, errors are categorized into Priority I findings and Priority II findings. Priority I status indicates a problem that can result in unusable data or a finding that the laboratory is unfit to perform services for DOE. Priority II status indicates problems that do not result in unusable data and do not indicate that the laboratory is unfit to perform services for DOE (DOE, 2002). There were no Priority I findings for STL and GEL.

The results of the STL audit included 13 Priority II findings: five radiological findings, four inorganic findings, one information management system finding, one waste management finding, and two general findings. The results of the GEL audit included 10 Priority II findings: one radiological finding, two inorganic findings, one information management system finding, and four general findings. Corrective action plans were submitted to DOE by both laboratories to document that procedures were put in place to correct these findings. Based on the audits, the analytical data met DOE's criteria for acceptable status.

9.8 CONCLUSIONS

Based on the data validations, data verifications, and results of the independent Performance Evaluation assessments, the chemical and radiological results reported in the *2004 Site Environmental Report* and SER Volume II, *Groundwater Status Report* are of acceptable quality.

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Acronyms and Abbreviations

These acronyms and abbreviations reflect the typical manner in which terms are used for this specific document and may not apply to all situations. Items with an asterisk (*) are described in the glossary of technical terms, which follows this list.

AGS	Alternating Gradient Synchrotron	CRMP	Cultural Resource Management Plan
ALARA*	"As Low As Reasonably Achievable"	Cs	cesium
AMSL	above mean sea level	CSF	Central Steam Facility
AOC*	area of concern	CWA*	Clean Water Act
APG	Analytical Products Group	CY	calendar year
ARARs	Applicable, Relevant, and Appropriate Requirements	D ₂ O*	heavy water
ARPA*	Archeological Resource Protection Act	DAC	Derived Air Concentration
AS/SVE*	air sparging/soil vapor extraction	DCA	1,1-dichloroethane
ASL	Analytical Services Laboratory (BNL)	DCE	1,1-dichloroethylene
AST	aboveground storage tank	DCG*	derived concentration guide
AWQS	Ambient Water Quality Standards	D&D	decontamination and decommissioning
BAF	Booster Applications Facility	DDD	dichlorodiphenyldichloroethane
BGD	belowground duct	DDE	dichlorodiphenyldichloroethylene
BGRR	Brookhaven Graphite Research Reactor	DDT	dichlorodiphenyltrichloroethane
BLIP	Brookhaven Linac Isotope Producer	DMR	Discharge Monitoring Report
BMRR	Brookhaven Medical Research Reactor	DOE*	U.S. Department of Energy
BNL	Brookhaven National Laboratory	DOE CH	DOE Chicago Operations Office
BOD*	biochemical oxygen demand	DQO	Data Quality Objective
Bq*	becquerel	DSB	Duct Service Building
Bq/g	becquerel per gram	DUV – FEL	Deep UltraViolet – Free Electron Laser
Bq/L	becquerel per liter	DWS	Drinking Water Standards
BSA	Brookhaven Science Associates	EA*	Environmental Assessment
Btu	British thermal units	EDB*	ethylene dibromide
CAA*	Clean Air Act	EDE*	Effective Dose Equivalent
CAAA*	CAA Amendments (1990)	EDTA	ethylenediaminetetraacetic acid
CAC	Community Advisory Council	EE/CA	Engineering Evaluation/Cost Analysis
CAP	Clean Air Act Assessment Package	EIMS*	Environmental Information Management System
CBS	chemical bulk storage	ELAP	Environmental Laboratory Approval Program
CEGPA	Community, Education, Government and Public Affairs	EML	Environmental Measurements Laboratory
CERCLA*	Comprehensive Environmental Response, Compensation and Liability Act	EMP	Environmental Monitoring Plan
CFC-11	an ozone-depleting refrigerant	EMS*	Environmental Management System
cfm, cfs	cubic feet per minute, per second	EPA*	U.S. Environmental Protection Agency
CFR	U.S. Code of Federal Regulations	EPCRA*	Emergency Planning and Community Right-to-Know Act
Ci*	curie	ER	environmental restoration
CO	certificate to operate	ERA	Environmental Resource Associates
COC*	chain-of-custody	ERD	Environmental Restoration Division
CRM	Cultural Resource Management	ES*	environmental surveillance
		ES&H	environment, safety, and health

APPENDIX A: GLOSSARY

ESA*	Endangered Species Act	MAPEP	Mixed Analyte Performance Evaluation Program
ESH&Q	Environment, Safety, Health, and Quality Directorate	MCL	maximum contaminant level
ESSH	Environmental Safety, Security and Health	MDL*	minimum detection limit
EWMSD	Environmental and Waste Management Services Division	MEI*	maximally exposed individual
FFCA*	Federal Facilities Compliance Act	MeV	million electron volts
FIFRA*	Federal Insecticide, Fungicide, and Rodenticide Act	MGD	million gallons per day
FRP	Facility Response Plan	mg/L	milligrams per liter
FWS*	U.S. Fish & Wildlife Service	MMBtu	million British thermal units
FY	fiscal year	MOA	Memorandum of Agreement
GBq	giga (billion or E+09) becquerel	MPF	Major Petroleum Facility
GAB	gross alpha and beta	MPN	most probable number
GC/ECD	gas chromatography/electron capture detector	mrem	milli (thousandth of a) rem
GC/MS	gas chromatography/mass spectrometry	MRC	Medical Research Center
GDS	Groundwater Discharge Standard	MSL*	mean sea level
GEL	General Engineering Laboratory, LLC	mSv	millisievert
GeV	giga (billion) electron volts	MTBE	methyl tertiary butyl ether
GIS	Geographical Information System	MW	megawatt
GWh	gigawatt hour	µg/L	micrograms per liter
H2M	H2M Labs, Inc.	NA	not analyzed
HEPA	high efficiency particulate air	NCRP	National Council on Radiation Protection and Measurements
HFBR	High Flux Beam Reactor	ND	not detected
HTO	tritiated water (liquid or vapor)	NEAR	Neighbors Expecting Accountability and Remediation
HVAC	heating/ventilation/air conditioning	NELAC	National Environmental Laboratory Accreditation Conference
HWMF	Hazardous Waste Management Facility	NELAP	National Environmental Laboratory Accreditation Program
I	Iodine	NEPA*	National Environmental Policy Act
IAEA	International Atomic Energy Agency	NESHAPs*	National Emission Standards for Hazardous Air Pollutants
IAG	Interagency Agreement	ng/J	nano (one-billionth) gram per Joule
IC	ion chromatography	NHPA*	National Historic Preservation Act
ICP/MS	inductively coupled plasma/mass spectrometry	NIST	National Institute for Standards and Technology
ISMS	Integrated Safety Management System	NO ₂	nitrogen dioxide
ISO*	International Organization for Standardization	NOV	Notice of Violation
K	potassium	NO _x *	nitrogen oxides
kBq	kilobecquerels (1,000 Bq)	NOEC	no observable effect concentration
KeV	kilo (thousand) electron volts	NPDES	National Pollutant Discharge Elimination System
Kr	kryptonite	NR	not required
kWh	kilowatt hours	NRMP	Natural Resource Management Plan
LDR	Land Disposal Restriction	NS	not sampled
LED	light emitting diode	NSF-ISR	NSF-International Strategic Registrations, Ltd.
LIE	Long Island Expressway	NSLS	National Synchrotron Light Source
Linac	Linear Accelerator	NT	not tested
LSTPD	Laboratory Science Teacher Professional Development	NYCRR*	New York Codes, Rules, and Regulations
MACT	Maximum Available Control Technology	NYS	New York State

NYSDEC	NYS Department of Environmental Conservation	SDWA*	Safe Drinking Water Act
NYSDOH	NYS Department of Health	SER	Site Environmental Report
NYSHPO	NYS Historic Preservation Office	SI	International System (measurement units)
O ₃ *	ozone	SNS	standard not specified
ODS	ozone-depleting substances	SO ₂	sulfur dioxide
OMC	Occupational Medical Clinic	SOP	standard operating procedure
ORC	oxygen-releasing compound	SPCC	Spill Prevention Control and Countermeasures
ORPS*	Occurrence Reporting and Processing System	SPDES*	State Pollutant Discharge Elimination System
OU*	operable unit	Sr	strontium
P2*	pollution prevention	STEM	Scanning Transmission Electron Microscope
PAAA*	Price-Anderson Act Amendment	STL	Severn Trent Laboratories, Inc.
PAF	Process Assessment Form	STP	Sewage Treatment Plant
Pb	lead	SU	standard unit
PBT	persistent, bioaccumulative, and toxic	SUNY	State University of New York
PCBs*	polychlorinated biphenyls	Sv*	sievert; unit for assessing radiation dose risk
PCE	tetrachloroethylene (or perchloroethylene)	SVE*	soil vapor extraction
pCi/g	picocuries per gram	SVOC*	semivolatile organic compound
PE	performance evaluation	t _{1/2} *	half-life
PET	positron emission tomography	TAG	Technical Advisory Group
ppb	parts per billion	TBq	tera (trillion, or E+12) becquerel
ppm	parts per million	TCA	1,1,1-trichloroethane
QA*	quality assurance	TCE*	trichloroethylene
QAPP	Quality Assurance Program Plan	TCLP	toxicity characteristic leaching procedure
QC*	quality control	TKN	Total Kjeldahl nitrogen
QM	Quality Management	TLD*	thermoluminescent dosimeter
R-11 (etc.)	ozone-depleting refrigerant	TPL	Target Processing Laboratory
RA*	removal action	TRE	Toxic Reduction Evaluation
RACT	Reasonably Available Control Technology	TRI	Toxic Release Inventory
RCRA*	Resource Conservation and Recovery Act	TSCA*	Toxic Substances Control Act
RF	resuspension factor	TVDG	Tandem Van de Graaff
RHIC	Relativistic Heavy Ion Collider	TVOC*	total volatile organic compounds
ROD*	Record of Decision	UIC*	underground injection control
RPD	relative percent difference	UST*	underground storage tank
RWMB	Radioactive Waste Management Basis	VOC*	volatile organic compound
RWP	Radiological Work Permit	VUV*	very ultraviolet
SARA*	Superfund Amendments and Reauthorization Act	WAC	waste acceptance criteria
SBMS*	Standards Based Management System	WCPP	Waste Certification Program Plan
SCDHS	Suffolk County Department of Health Services	WCF	Waste Concentration Facility
SCSC	Suffolk County Sanitary Code	WET	Whole Effluent Toxicity
SDL	Source Development Laboratory	WM	Waste Management
		WMF	Waste Management Facility
		WTP	Water Treatment Plant

Technical Terms

These definitions reflect the typical manner in which the terms are used for this specific document and may not apply to all situations. Bold-face words in the descriptions are defined in separate entries.

A

AA (atomic absorption) – A spectroscopy method used to determine the elemental composition of a sample. In this method, the sample is vaporized and the amount of light it absorbs is measured.

accuracy – The degree of agreement of a measurement with an accepted reference or true value. It can be expressed as the difference between two values, as a percentage of the reference or true value, or as a ratio of the measured value and the reference or true value.

activation – The process of making a material radioactive by bombardment with neutrons, protons, or other high energy particles.

activation product – A material that has become radioactive by bombardment with neutrons, protons, or other high energy particles.

activity – Synonym for radioactivity.

Administrative Record – A collection of documents established in compliance with **CERCLA**. Consists of information the CERCLA lead agency uses in its decision on the selection of response actions. The Administrative Record file should be established at or near the facility and made available to the public. An Administrative Record can also be the record for any enforcement case.

aerobic – An aerobic organism is one that lives, acts, or occurs only in the presence of oxygen.

aerosol – A gaseous suspension of very small particles of liquid or solid.

ALARA (As Low As Reasonably Achievable) – A phrase that describes an approach to minimize exposures to individuals and minimize releases of radioactive or other harmful material to the **environment** to levels as low as social, technical, economic, practical, and public policy considerations will permit. ALARA is not a dose limit, but a process with a goal to keep dose levels as far below applicable limits as is practicable.

alpha radiation – The emission of alpha particles during radioactive decay. Alpha particles are identical in makeup to the nucleus of a helium atom and have a positive charge. Alpha radiation is easily stopped by materials as thin as a sheet of paper and has a range in air of only an inch or so. Despite its low penetration ability, alpha radiation is densely ionizing and therefore very damaging when ingested or inhaled. Naturally occurring radioactive sources such as radon emit alpha radiation.

air stripping – A process for removing **VOCs** from contaminated water by forcing a stream of air through the water in a vessel. The contaminants evaporate into the air stream. The air may be further treated before it is released into the atmosphere.

ambient air – The surrounding atmosphere, usually the outside air, as it exists around people, animals, plants, and structures. It does not include the air immediately adjacent to emission sources.

analyte – A constituent that is being analyzed.

anneal – To heat a material and then cool it. In the case of thermoluminescent dosimeters (TLDs), this is done to reveal the amount of radiation the material had absorbed.

anion – A negatively charged ion, often written as a superscript negative sign after an element symbol, such as Cl^- .

anthropogenic – Resulting from human activity; anthropogenic radiation is human-made, not naturally occurring.

AOC (area of concern) – Under **CERCLA**, this term refers to an area where releases of hazardous substances may have occurred or a location where there has been a release or threat of a release of a hazardous substance, pollutant, or contaminant (including **radionuclides**). AOCs may include, but need not be limited to, former spill areas, landfills, surface impoundments, waste piles, land treatment units, transfer stations, wastewater treatment units, incinerators, container storage areas, scrap yards, cesspools, tanks, and associated piping that are known to have caused a release into the environment or whose integrity has not been verified.

aquifer – A water-saturated layer of rock or soil below the ground surface that can supply usable quantities of **groundwater** to wells and springs. Aquifers can be a source of water for domestic, agricultural, and industrial uses.

ARPA (Archaeological Resources Protection Act) This law, passed in 1979, has been amended four times. It protects any material remains of past human life or activities that are of archaeological interest. Known *and potential* sites of interest are protected from uncontrolled excavations and pillage, and artifacts found on public and Indian lands are banned from commercial exchange. (source: www.cr.nps.gov/linklaws.htm, accessed 3-7-05)

AS/SVE (air sparging/soil vapor extraction) – A method of extracting **volatile organic compounds** from the **groundwater**, in place, using compressed air. (In contrast, air stripping occurs in a vessel.) The vapors are typically collected using a soil vapor extraction system.

B

background – A sample or location used as reference or control to compare BNL analytical results to those in areas that could not have been impacted by BNL operations.

background radiation – **Radiation** present in the environment as a result of naturally occurring radioactive materials in the Earth, cosmic radiation, or human-made radiation sources, including fallout.

beta radiation – Beta radiation is composed of charged particles emitted from a nucleus during radioactive decay. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Beta radiation is more penetrating than alpha radiation, but it may be stopped by materials such as aluminum or Lucite™ panels. Naturally occurring radioactive elements such as potassium-40 emit beta radiation.

blank – A sample (usually reagent-grade water) used for quality control of field sampling methods, to demonstrate that cross contamination has not occurred.

blowdown – Water discharged from either a boiler or cooling tower in order to prevent the build-up of inorganic matter within the boiler or tower and to prevent scale formation (i.e., corrosion).

BOD (biochemical oxygen demand) – A measure of the amount of oxygen in biological processes that breaks down organic matter in water; a measure of the organic pollutant load. It is used as an indicator of water quality.

Bq (becquerel) – A quantitative measure of **radioactivity**. This alternate measure of activity is used internationally and with increasing frequency in the United States. One Bq of activity is equal to one nuclear decay per second.

bremsstrahlung – Translates as “fast braking” and refers to electromagnetic radiation produced by the sudden retardation of a charged particle in an intense electric field.

C

CAA (Clean Air Act), CAA Amendments (CAAA) – The original Clean Air Act was passed in 1963, but the U.S. air pollution control program is based on the 1970 version of the law. The 1990 Clean Air Act Amendments (CAAA) are the most far-reaching revisions of the 1970 law. In common usage, references to the CAA typically mean to the 1990 amendments. (source: EPA’s “Plain English Guide to the Clean Air Act” glossary @ www.epa.gov/oar/oagps/peg_caa, accessed 3-7-05)

caisson – A watertight container used in construction work under water or as a foundation.

cap – A layer of natural or synthetic material, such as clay or gunite, used to prevent rainwater from penetrating and spreading contamination. The surface of the cap is generally mounded or sloped so water will drain off.

carbon adsorption/carbon treatment – A treatment system in which contaminants are removed from **groundwater**, surface water, and air by forcing water or air through

tanks containing activated carbon (a specially treated material that attracts and holds or retains contaminants).

carbon tetrachloride – A poisonous, nonflammable, colorless liquid, CCl₄.

CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) – Pronounced “sir-klah” and commonly known as Superfund, this law was enacted by Congress on December 11, 1980. It created a tax on the chemical and petroleum industries and provided broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. CERCLA established prohibitions and requirements concerning closed and abandoned hazardous waste sites; provided for liability of persons responsible for releases of hazardous waste at these sites; and established a trust fund to provide for cleanup when no responsible party could be identified.

The law authorizes two kinds of response actions: short-term removals, where actions may be taken to address releases or threatened releases requiring prompt response, and long-term remedial response actions that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening. These actions can be conducted only at sites listed on EPA’s National Priorities List (NPL). CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA) on October 17, 1986. (source: EPA web site www.epa.gov/superfund/action/law/cercla.htm, accessed 03-7-05)

CFR (Code of Federal Regulations) – A codification of all regulations developed and finalized by federal agencies in the Federal Register. The CFR is arranged by “title,” with Title 10 covering energy- and radiation-related issues, and Title 40 covering protection of the environment. Subparts within the titles are included in citations, as in “40 CFR Subpart H.” The CFR is available online at www.gpoaccess.gov/cfr/index.html (accessed 3-7-05).

characterization – Facility or site sampling, monitoring, and analysis activities to determine the extent and nature of contamination. Characterization provides the basis of necessary technical information to select an appropriate cleanup alternative.

Ci (curie) – A quantitative measure of radioactivity. One Ci of activity is equal to 3.7E+10 decays per second. One curie has the approximate activity of 1 gram of radium. It is named after Marie and Pierre Curie, who discovered radium in 1898.

Class GA groundwater – New York State Department of Environmental Conservation classification for high quality groundwater, where the best intended use is as a source of drinking water supply.

closure – Under RCRA regulations, this term refers to a hazardous or solid waste management unit that is no longer operating and where potential hazards that it posed have been addressed (through clean up, immobilization, capping, etc.) to the satisfaction of the regulatory agency.

COC (chain-of-custody) – A method for documenting the history and possession of a sample from the time of collection, through analysis and data reporting, to its final disposition.

cocktail – a mixture of chemicals used for **scintillation** counting.

collective Effective Dose Equivalent – A measure of health risk to a population exposed to radiation. It is the sum of the **EDEs** of all individuals within an exposed population, frequently considered to be within 50 miles (80 kilometers) of an environmental release point. It is expressed in **person-rem** or **person-sievert**.

Committed Effective Dose Equivalent – The total **EDE** received over a 50-year period following the internal deposition of a **radionuclide**. It is expressed in **rem**s or **sieverts**.

composite sample – A sample of an environmental medium containing a certain number of sample portions collected over a period of time, possibly from different locations. The constituent samples may or may not be collected at equal time intervals over a predefined period of time, such as 24 hours.

confidence interval – A numerical range within which the true value of a measurement or calculated value lies. In the SER, radiological values are shown with a 95 percent confidence interval: there is a 95 percent probability that the true value of a measurement or calculated value lies within the specified range. *See also* “Uncertainty” discussion in Appendix B.

conservative – Estimates that err on the side of caution because all possibly deleterious components are included at generous or high values.

contamination – Unwanted radioactive and/or hazardous material that is dispersed on or in equipment, structures, objects, air, soil, or water.

control – *See background.*

cooling water – Water used to cool machinery and equipment. *Contact* cooling water is any wastewater that contacts machinery or equipment to remove heat from the metal; *noncontact* cooling water has no direct contact with any process material or final product. *Process wastewater* cooling water is water used for cooling that may have become contaminated through contact with process raw materials or final products.

cover boards – Sheets of plywood placed on the ground near ponds to serve as attractive habitat for salamanders, as part of a population study.

curie – *See Ci.*

CWA (Clean Water Act) – Growing public awareness and concern for controlling water pollution led to enactment of the Federal Water Pollution Control Act Amendments of 1972. As amended in 1977, this law became commonly known as the Clean Water Act. It established the basic structure for regulating discharges of pollutants into the waters of the United States, giving **EPA** the authority to implement

pollution control programs such as setting wastewater standards for industry. The CWA also continued requirements to set water quality standards for all contaminants in surface waters and made it unlawful for any person to discharge any pollutant from a **point source** into navigable waters unless a permit was obtained. The CWA also funded the construction of sewage treatment plants and recognized the need for planning to address the critical problems posed by **nonpoint source pollution**.

Revisions in 1981 streamlined the municipal construction grants process. Changes in 1987 phased out the construction grants program. Title I of the Great Lakes Critical Programs Act of 1990 put into place parts of the Great Lakes Water Quality Agreement of 1978, signed by the U.S. and Canada; the two nations agreed to reduce certain toxic pollutants in the Great Lakes. Over the years many other laws have changed parts of the CWA. (*source: www.epa.gov/region5/water/cwa.htm, accessed 03-7-05*)

D

D₂O – *See heavy water.*

daughter, progeny – A given **nuclide** produced by radioactive decay from another nuclide (the “parent”). *See also radioactive series.*

DCG (derived concentration guide) – The concentration of a **radionuclide** in air or water that, under conditions of continuous exposure for one year by a single pathway (e.g., air inhalation, absorption, or ingestion), would result in an effective dose equivalent of 100 mrem (1 mSv). The values were established in **DOE Order 5400.5**.

decay product – A **nuclide** resulting from the radioactive disintegration of a **radionuclide**, being formed either directly or as a result of successive transformations in a radioactive series. A decay product may be either radioactive or stable.

decontamination – The removal or reduction of **radioactive** or hazardous contamination from facilities, equipment, or soils by washing, heating, chemical or electrochemical action, mechanical cleaning, or other techniques to achieve a stated objective or end condition.

disposal – Final placement or destruction of waste.

DOE (Department of Energy) – The federal agency that promotes scientific and technical innovation to support the national, economic, and energy security of the United States. DOE has responsibility for 10 national laboratories and for the science and research conducted at these laboratories, including Brookhaven National Laboratory.

DOE Order 231.1A – This order, Environment, Safety, and Health Reporting, is dated 8/19/03. It replaces the 1995 version, Order 231.1, as well as the “ORPS” order, DOE Order 232.1A, Occurrence Reporting and Processing of Operations Information, dated 7/21/97, and Order 210.1, Performance Indicator..., dated 9/27/95. It can be found at www.directives.doe.gov (accessed 3/7/05).

DOE Order 450.1 – This order, Environmental Protection

Program, is dated 1/15/03. It replaces DOE Order 5400.1, General Environmental Protection Program, dated 11/9/88. It can be found at www.directives.doe.gov (accessed 3/7/05).

DOE Order 5400.5 – This order, Radiation Protection of the Public and the Environment, was first published by DOE in 1990 and was modified in 1993. It established the standards and requirements for operations of DOE and DOE contractors with respect to protecting the public and the **environment** against undue risk from radiation. It can be found at www.directives.doe.gov (accessed 3/7/05).

dose – See **EDE**.

dosimeter – A portable detection device for measuring exposure to ionizing radiation. See Chapter 8 for details.

downgradient – In the direction of **groundwater** flow from a designated area; analogous to “downstream.”

DQO (Data Quality Objective) – The Data Quality Objective (DQO) process was developed by EPA for facilities to use when describing their environmental monitoring matrices, sampling methods, locations, frequencies, and measured parameters, as well as methods and procedures for data collection, analysis, maintenance, reporting, and archiving. The DQO process also addresses data that monitor quality assurance and quality control.

drift fence – A stretch of temporary fencing to prevent an animal population from leaving the area, used at BNL as part of a population study.

dry weight – The dry weight concentration of a substance is after a sample is dried for analysis. Dry weight concentrations are typically higher than wet weight values.

D-waste – Liquid waste containing radioactivity.

E

EA (Environmental Assessment) – A report that identifies potentially significant effects from any federally approved or funded project that might change the physical **environment**. If an EA identifies a “significant” potential impact (as defined by NEPA), an Environmental Impact Statement (EIS) must be researched and prepared.

EDB (ethylene dibromide) – A colorless, nonflammable, heavy liquid with a sweet odor; slightly soluble in water. Although the U.S. Department of Health and Human Services has determined that ethylene dibromide may reasonably be anticipated to be a carcinogen, it is still used to treat felled logs for bark beetles; to control wax moths in beehives; as a chemical intermediary for dyes, resins, waxes, and gums; to spot-treat milling machinery; and to control Japanese beetles in ornamental plants.

EDE (Effective Dose Equivalent) – A value used to express the health risk from radiation exposure to tissue in terms of an equivalent whole body exposure. It is a “normalized” value that allows the risk from radiation exposure received by a specific organ or part of the body to be compared with the risk due to whole-body exposure. The EDE equals the

sum of the doses to different organs of the body multiplied by their respective **weighting factors**. It includes the sum of the EDE due to radiation from sources external to the body and the committed effective dose equivalent due to the internal deposition of **radionuclides**. EDE is expressed in **rems** or **sieverts**.

effluent – Any liquid discharged to the environment, including stormwater **runoff** at a site or facility.

EIMS (Environmental Information Management System) – A database system used to store, manage, verify, protect, retrieve, and archive BNL’s environmental data.

EM (environmental monitoring) – Sampling for contaminants in air, water, sediment, soil, food stuffs, plants, and animals, either by directly measuring or by collecting and analyzing samples.

emissions – Any gaseous or particulate matter discharged to the atmosphere.

EMS (Environmental Management System) – The BNL EMS meets the requirements of the **ISO 14001 EMS standard**, with emphasis on compliance assurance, pollution prevention, and community outreach. An extensive environmental monitoring program is one component of BNL’s EMS.

environment – Surroundings (including air, water, land, natural resources, flora, fauna, and humans) in which an organization operates, and the interrelation of the organization and its surroundings.

environmental aspect – Elements of an organization’s activities, products, or services that can interact with the surrounding air, water, land, natural resources, flora, fauna, and humans.

environmental impact – Any change to the surrounding air, water, land, natural resources, flora, and fauna, whether adverse or beneficial, wholly or partially resulting from an organization’s activities, products, or services.

environmental media – Includes air, **groundwater**, surface water, soil, flora, and fauna.

environmental monitoring or surveillance – See **EM**.

EPA (U. S. Environmental Protection Agency) – The federal agency responsible for developing and enforcing environmental laws. Although state or local regulatory agencies may be authorized to administer environmental regulatory programs, EPA generally retains oversight authority.

EPCRA (Emergency Planning and Community Right-to-Know Act) – Also known as Title III of SARA, EPCRA was enacted by Congress as the national legislation on community safety, to help local groups protect public health, safety, and the environment from chemical hazards. To implement EPCRA, Congress required each state to appoint a State Emergency Response Commission (SERC). The SERCs were required to divide their states into Emergency Planning Districts and to name a Local Emergency Planning Committee for each district.

Broad representation by fire fighters, health officials, government and media representatives, community groups, industrial facilities, and emergency managers ensures that all necessary elements of the planning process are represented. (source: www.epa.gov/region5/defs/html/epcra.htm, accessed 3-7-05)

ES (environmental surveillance) – Sampling for contaminants in air, water, sediment, soil, food stuffs, plants, and animals, either by directly measuring or by collecting and analyzing samples.

ESA (Endangered Species Act) – This provides a program for conserving threatened and endangered plants and animals and their habitats. The **FWS** maintains the list of 632 *endangered* species (326 are plants) and 190 *threatened* species (78 are plants). Species include birds, insects, fish, reptiles, mammals, crustaceans, flowers, grasses, and trees. Anyone can petition FWS to include a species on this list. The law prohibits any action, administrative or real, that results in a “taking” of a listed species *or* adversely affects habitat. Likewise, import, export, interstate, and foreign commerce of listed species are all prohibited. **EPA**’s decision to register pesticides is based in part on the risk of adverse effects on endangered species as well as environmental fate (how a pesticide will affect habitat). Under **FIFRA**, **EPA** can issue emergency suspensions of certain pesticides to cancel or restrict their use if an endangered species will be adversely affected. (source: www.epa.gov/region5/defs/html/esa.htm, accessed 3-7-05)

evapotranspiration – A process by which water is transferred from the soil to the air by plants that take the water up through their roots and release it through their leaves and other aboveground tissue.

exposure – A measure of the amount of ionization produced by **x-rays** or **gamma rays** as they travel through air. The unit of radiation exposure is the roentgen (**R**).

F

fallout – Radioactive material, made airborne as a result of aboveground nuclear weapons testing, that has been deposited on the Earth’s surface.

FFCA (Federal Facility Compliance Act) – Formerly, the federal government maintained that it was not subject to fines and penalties under solid and hazardous waste law because of the doctrine of “sovereign immunity.” The State of Ohio challenged this in *Ohio v. the Department of Energy* (1990). The U.S. Circuit Court of Appeals found in favor of the State (June 11, 1990), writing that the federal government’s sovereign immunity is waived under both the **CWA** sovereign immunity provision and **RCRA**’s citizen suit provision. The Circuit Court decision was overturned by the Supreme Court on April 21, 1992, in *DOE v. Ohio*, which held that the waiver of sovereign immunity in **RCRA** and **CWA** is not clear enough to allow states to impose civil penalties directly. After the high court’s ruling, the consensus among lawmakers was that a double standard existed: the same government that developed laws to protect human health and the environment and required compliance in the

private sector, was itself not assuming the burden of compliance. As a result, Congress enacted the **FFCA** (October 6, 1992, Pub. Law 102-386), which effectively overturned the Supreme Court’s ruling. In the legislation Congress specifically waived sovereign immunity with respect to **RCRA** for federal facilities.

Under section 102, **FFCA** amends section 6001 of **RCRA** to specify that federal facilities are subject to “all civil and administrative penalties and fines, regardless of whether such penalties or fines are punitive or coercive in nature.” These penalties and fines can be levied by **EPA** or by authorized states. In addition, **FFCA** states that “the United States hereby expressly waives any immunity otherwise applicable to the United States.” Although federal agents, employees, and officers are not liable for civil penalties, they are subject to criminal sanctions. No departments, agencies, or instrumentalities are subject to criminal sanctions. Section 104 (1) and (2) require **EPA** to conduct annual **RCRA** inspections of all federal facilities. (source: <http://tis.eh.doe.gov/oeqa/laws/ffca.html>, accessed 3-7-05)

FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) – The primary focus of this law was to provide federal control of pesticide distribution, sale, and use. **EPA** was given authority under **FIFRA** not only to study the consequences of pesticide usage but also to require users (farmers, utility companies, and others) to register when purchasing pesticides. Through later amendments to the law, users also must take exams for certification as applicators of pesticides. All pesticides used in the U.S. must be registered (licensed) by **EPA**. Registration assures that pesticides will be properly labeled and that if used in accordance with specifications, will not cause unreasonable harm to the environment. (source: www.epa.gov/region5/defs/html/fifra.htm, accessed 3-7-05)

FS (feasibility study) – A process for developing and evaluating remedial actions using data gathered during the remedial investigation. The **FS** defines the objectives of the remedial program for the site and broadly develops remedial action alternatives, performs an initial screening of these alternatives, and performs a detailed analysis of a limited number of alternatives that remain after the initial screening stage.

FWS (U.S. Fish & Wildlife Service) – The U.S. Fish and Wildlife Service is the principal federal agency responsible for conserving, protecting, and enhancing fish, wildlife, plants, and their habitats for the continuing benefit of the people of the United States. **FWS** manages the 95-million-acre National Wildlife Refuge System, which encompasses 544 national wildlife refuges, thousands of small wetlands, and other special management areas. It also operates 69 national fish hatcheries, 64 fishery resources offices, and 81 ecological services field stations. The agency enforces federal wildlife laws, administers the Endangered Species Act, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, and helps foreign and Native American tribal governments

with their conservation efforts. It also oversees the Federal Assistance Program, which distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state fish and wildlife agencies. (*source:* <http://northeast.fws.gov/ameel/petition.html>, accessed 3/7/05)

fugitive source – Unanticipated sources of volatile hazardous air pollutants due to leaks from valves, pumps, compressors, relief valves, connectors, flanges, and various other pieces of equipment.

G

gamma radiation – Gamma radiation is a form of electromagnetic radiation, like radio waves or visible light, but with a much shorter wavelength. It is more penetrating than **alpha** or **beta** radiation, capable of passing through dense materials such as concrete.

gamma spectroscopy – This analysis technique identifies specific **radionuclides**. It measures the particular energy of a radionuclide's gamma radiation emissions. The energy of these emissions is unique for each nuclide, acting as a "fingerprint."

geotextile – A product used as a soil reinforcement agent and as a filter medium. It is made of synthetic fibers manufactured in a woven or loose manner to form a blanket-like product.

grab sample – A single sample collected at one time and place.

Green Building – Construction that adheres to guidelines established by the Green Building Council, a coalition of leaders from across the building industry working to promote structures that are environmentally responsible, profitable, and healthy places to live and work.

groundwater – Water found beneath the surface of the ground (subsurface water). Groundwater usually refers to a zone of complete water saturation containing no air.

gunite – A mixture of cement, sand, and water sprayed over a mold to form a solid, impermeable surface. Formerly a trademarked name, now in general usage.

H

half-life ($t_{1/2}$) – The time required for one-half of the atoms of any given amount of a radioactive substance to disintegrate; the time required for the activity of a radioactive sample to be reduced by one half.

halon – An ozone-depleting fire suppressant; suffixes (-1301, etc.) indicate variants.

hazardous waste – Toxic, corrosive, reactive, or ignitable materials that can injure human health or damage the environment. It can be liquid, solid, or sludge, and include heavy metals, organic solvents, reactive compounds, and corrosive materials. It is defined and regulated by **RCRA**, Subtitle C.

heat input – The heat derived from combustion of fuel in a steam generating unit. It does not include the heat from

preheated combustion air, recirculated flue gases, or the exhaust from other sources.

heavy water (D_2O) – A form of water containing deuterium, a nonradioactive isotope of hydrogen.

herpetofaunal – Relating to the study of reptiles.

hot cell – Shielded and air-controlled facility for the remote handling of radioactive material.

hydrology – The science dealing with the properties, distribution, and circulation of natural water systems.

I

inert – Lacking chemical or biological action.

influent – Liquid (such as stormwater runoff or wastewater) flowing into a reservoir, basin, or treatment plant.

intermittent river – A stream that dries up on occasion, usually as a result of seasonal factors or decreased contribution from a source such as a wastewater treatment plant.

ionizing radiation – Any radiation capable of displacing electrons from atoms or molecules, thereby producing ions. High doses of ionizing radiation may produce severe skin or tissue damage. *See also* **alpha, beta, gamma radiation; x-rays**.

ISO 14001 EMS standard – The International Organization for Standardization (ISO) sets standards for a wide range of products and management operations. Following the success of the ISO 9000 Standards for quality management, ISO introduced the 14000 series for environmental management. BNL was the first DOE Office of Science laboratory to obtain third-party registration to this globally recognized environmental standard.

isotope – Two or more forms of a chemical element having the same number of protons in the nucleus (the same atomic number), but having different numbers of neutrons in the nucleus (different atomic weights). Isotopes of a single element possess almost identical chemical properties.

L

leaching – The process by which soluble chemical components are dissolved and carried through soil by water or some other percolating liquid.

light water – As used in this document, tap water, possibly filtered.

liquid scintillation counter – An analytical instrument used to quantify tritium, carbon-14, and other beta-emitting **radionuclides**. *See also* **scintillation**.

M

matrix, matrices – The natural context (e.g., air, vegetation, soil, water) from which an environmental sample is collected.

MDL (minimum detection limit) – The lowest level to which an analytical parameter can be measured with certainty by the analytical laboratory performing the measurement. While results below the MDL are sometimes measur-

able, they represent values that have a reduced statistical confidence associated with them (less than 95 percent confidence).

MEI (maximally exposed individual) – The hypothetical individual whose location and habits tend to maximize his/her radiation dose, resulting in a dose higher than that received by other individuals in the general population.

metamorphic – In the state of changing from larval to mature forms.

mixed waste – Waste that contains both a hazardous waste component (regulated under Subtitle C of **RCRA**) and a radioactive component.

monitoring – The collection and analysis of samples or measurements of effluents and emissions for the purpose of characterizing and quantifying contaminants, and demonstrating compliance with applicable standards.

monitoring well – A well that collects **groundwater** for the purposes of evaluating water quality, establishing groundwater flow and elevation, determining the effectiveness of treatment systems, and determining whether administrative or engineered controls designed to protect groundwater are working as intended.

MSL (mean sea level) – The average height of the sea for all stages of the tide. Used as a benchmark for establishing **groundwater** and other elevations.

N

NEPA (National Environmental Policy Act) – Assures that all branches of government give proper consideration to the environment before any land purchase or any construction projects, including airports, buildings, military complexes, and highways. Project planners must assess the likely impacts of the project by completing an Environmental Assessment (EA) and, if necessary, an Environmental Impact Statement (EIS). (source: www.epa.gov/region5/defs/html/nepa.htm, accessed 3-7-05)

NESHAPs (National Emissions Standards for Hazardous Air Pollutants) – Standards that limit emissions from specific sources of air pollutants linked to serious health hazards. NESHAPs are developed by **EPA** under the CAA. Hazardous air pollutants can be chemical or radioactive. Their sources may be human-made, such as vehicles, power plants, and industrial or research processes, or natural, such as radioactive gas in soils. (source: www.epa.gov/radiation/neshaps, accessed 3-7-05)

neutrino – A small, neutral particle created as a result of particle decay. Neutrinos were believed to be massless, but recent studies have indicated that they have small, but finite, mass. Neutrinos interact very weakly.

NHPA (National Historic Preservation Act) – With passage of the National Historic Preservation Act in 1966, Congress made the federal government a full partner and a leader in historic preservation. The role of the federal government is fulfilled through the National Park Service. State participation is through State Historic Preservation Offices.

“Before 1966, historic preservation was mainly understood in one-dimensional terms: the proverbial historic shrine or Indian burial mound secured by lock and key—usually in a national park—set aside from modern life as an icon for study and appreciation. NHPA largely changed that approach, signaling a much broader sweep that has led to the breadth and scope of the vastly more complex historic preservation mosaic we know today.” (source: www.achp.gov/overview.html, accessed 3-7-05)

nonpoint source pollution – Nonpoint source pollution occurs when rainfall, snowmelt, or irrigation water runs over land or through the ground, picks up pollutants, and deposits them into rivers, lakes, and coastal waters or introduces them into **groundwater**. Nonpoint source pollution also includes adverse changes to the hydrology of water bodies and their associated aquatic habitats. After Congress passed the Clean Water Act in 1972, the nation’s water quality community emphasized **point source** pollution (coming from a discrete conveyance or location, such as industrial and municipal waste discharge pipes). Point sources were the primary contributors to the degradation of water quality then, and the significance of nonpoint source pollution was poorly understood. Today, nonpoint source pollution remains the largest source of water quality problems. It is the main reason that approximately 40 percent of surveyed rivers, lakes, and estuaries are not clean enough to meet basic uses such as fishing or swimming. (source: www.epa.gov/owow/nps, accessed 3-7-05)

NO_x – Nitrogen oxides are gases consisting of one molecule of nitrogen and varying numbers of oxygen molecules. Nitrogen oxides are produced, for example, by the combustion of fossil fuels in vehicles and electric power plants. In the atmosphere, NO_x can contribute to the formation of smog, impair visibility, and have health consequences. NO_x are considered “criteria air pollutants” under the CAA.

nuclide – A species of atom characterized by the number of protons and neutrons in the nucleus.

NYCRR (New York Codes, Rules, and Regulations) The NYCRR primarily contains state agency rules and regulations adopted under the State Administrative Procedure Act. There are 22 Titles: one for each state department, one for miscellaneous agencies and one for the Judiciary. Title 6 addresses environmental conservation, so many references in the SER are to “6 NYCRR.”

O

O₃ – See ozone.

on site – The area within the boundaries of a site that is controlled with respect to access by the general public.

opacity – Under the Clean Air Act (CAA), a measurement of the degree to which smoke (emissions other than water vapor) reduces the transmission of light and obscures the view of an object in the background.

ORPS (Occurrence Reporting and Processing System) A system for identifying, categorizing, notifying, investigat-

ing, analyzing, and reporting to DOE events or conditions discovered at the BNL site. It was originally established by DOE Order 232.1, which has been replaced by **DOE Order 231.1A**.

OU (operable unit) – Division of a contaminated site into separate areas based on the complexity of the problems associated with it. Operable units may address geographical portions of a site, specific site problems, or initial phases of an action. They may also consist of any set of actions performed over time, or actions that are concurrent, but located in different parts of a site. An OU can receive specific investigation and a particular remedy may be proposed. A Record of Decision (**ROD**) is prepared for each OU.

outfall – The place where wastewater is discharged.

oxides of nitrogen (NO_x) – See NO_x.

ozone (O₃) – A very reactive type of oxygen formed naturally in the upper atmosphere which provides a shield for the earth from the sun's ultraviolet rays. At ground level or in the lower atmosphere, it is pollution that forms when oxides of nitrogen and hydrocarbons react with oxygen in the presence of strong sunlight. Ozone at ground level can lead to health effects and cause damage to trees and crops.

P

P2 (pollution prevention) – Preventing or reducing the generation of pollutants, contaminants, hazardous substances, or wastes at the source, or reducing the amount for treatment, storage, and disposal through recycling. Pollution prevention can be achieved through reduction of waste at the source, segregation, recycle/reuse, and the efficient use of resources and material substitution. The potential benefits of pollution prevention include the reduction of adverse environmental impacts, improved efficiency, and reduced costs.

PAAA (Price-Anderson Act Amendments) – The Price-Anderson Act (PAA) was passed in 1957 to provide for prompt compensation in the case of a nuclear accident. The PAA provided broad financial coverage for damage, injury, and costs, and required DOE to indemnify contractors. The amended act of 1988 (PAAA) extended indemnification for 15 years and required DOE to establish and enforce nuclear safety rules. The PAAA Reauthorization, passed in December of 2002, extended current indemnification levels through 2004. 10 CFR 820 and its Appendix A provide DOE enforcement procedure and policy. (source: <http://tis.eh.doe.gov>, accessed 3-24-04)

Parshall flume – An engineered channel used to measure the flow rate of water. It was named after the inventor, who worked for the U.S. government as an irrigation research engineer.

PCBs (polychlorinated biphenyls) – A family of organic compounds used from 1926 to 1979 (when they were banned by EPA) in electrical transformers, lubricants, carbonless copy paper, adhesives, and caulking compounds. PCBs are extremely persistent in the environment because they do not break down into different and less harmful chemicals. PCBs are stored in the fatty tissues of humans and animals

through the bioaccumulation process.

percent recovery – For analytical results, the ratio of the measured amount, divided by the known (spiked) amount, multiplied by 100.

permit – An authorization issued by a federal, state, or local regulatory agency. Permits are issued under a number of environmental regulatory programs, including CAA, CWA, RCRA, and TSCA. Permits grant permission to operate, to discharge, to construct, and so on. Permit provisions may include emission/effluent limits and other requirements such as the use of pollution control devices, monitoring, record keeping and reporting. Also called a “license” or “certificate” under some regulatory programs.

pH – A measure of hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH less than 7, neutral solutions have a pH of 7, and basic solutions have a pH greater than 7 and up to 14.

plume – A body of contaminated groundwater or polluted air flowing from a specific source. The movement of a groundwater plume is influenced by such factors as local groundwater flow patterns, the character of the aquifer in which groundwater is contained, and the density of contaminants. The movement of an air contaminant plume is influenced by the ambient air motion, the temperatures of the ambient air and of the plume, and the density of the contaminants.

point source – Any confined and discrete conveyance (e.g., pipe, ditch, well, or stack) of a discharge.

pollutant – Any hazardous or radioactive material naturally occurring or added to an environmental medium, such as air, soil, water, or vegetation.

potable water – Water of sufficient quality for use as drinking water without endangering the health of people, plants, or animals.

precision – A statistical term describing the dispersion of data around a central value, usually represented as a variance, standard deviation, standard error, or confidence interval.

putrescible waste – Garbage that contains food and other organic biodegradable materials. There are special management requirements for this waste in 6 NYCRR Part 360.

Q

QA (quality assurance) – In environmental monitoring, any action to ensure the reliability of monitoring and measurement data. Aspects of QA include procedures, inter-laboratory comparison studies, evaluations, and documentation.

QC (quality control) – In environmental monitoring, the routine application of procedures to obtain the required standards of performance in monitoring and measurement processes. QC procedures include calibration of instruments, control charts, and analysis of replicate and duplicate samples.

qualifier – A letter or series of letter codes in a graph or chart indicating that the associated value did not meet analytical requirements or was estimated.

quenching – Anything that interferes with the conversion of decay energy to electronic signal in the photomultiplier tubes of detection equipment, usually resulting in a reduction in counting efficiency.

R

R (roentgen) – A unit of exposure to ionizing radiation. It is the amount of gamma or x-rays required to produce ions carrying one electrostatic unit of electrical charge in one cubic centimeter of dry air under standard conditions. It is named after the German scientist Wilhelm Roentgen, who discovered x-rays.

RA (removal actions, “removals”) – Interim actions that are undertaken to prevent, minimize, or mitigate damage to the public health or environment that may otherwise result from a release or threatened release of hazardous substances, pollutants, or contaminants pursuant to **CERCLA**, and that are not inconsistent with the final remedial action. Under **CERCLA**, **EPA** may respond to releases or threats of releases of hazardous substances by starting an RA to stabilize or clean up an incident or site that immediately threatens public health or welfare. Removal actions are less comprehensive than *remedial* actions. However, removal actions must contribute to the efficiency of future remedial actions.

radiation – Some atoms possess excess energy, causing them to be physically unstable. Such atoms become stable when the excess energy is released in the form of charged particles or electromagnetic waves, known as radiation.

radiation event – A single detection of a charged particle or electromagnetic wave.

radioactive series – A succession of **nuclides**, each of which transforms by radioactive disintegration into the next until a stable nuclide results. The first member of the series is called the parent and the intermediate members are called daughters or progeny.

radioactivity – The spontaneous transition of an atomic nucleus from a higher energy to a lower energy state. This transition is accompanied by the release of a charged particle or electromagnetic waves from the atom. Also known as “activity.”

radionuclide – A radioactive element characterized by the number of protons and neutrons in the nucleus. There are several hundred known radionuclides, both artificially produced and naturally occurring.

RCRA (Resource Conservation and Recovery Act) Pronounced “rick-rah,” this act of Congress gave **EPA** the authority to control the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of nonhazardous wastes. The 1986 amendments to RCRA enabled **EPA** to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. RCRA focuses only on active and future facilities and does not address abandoned or historical sites (see **CERCLA**). In 1984, amendments to RCRA called the

Hazardous and Solid Waste Amendments (HSWA, pronounced “hiss-wa”) required phasing out the land disposal of hazardous waste. Some other mandates of this strict law include increased enforcement authority for **EPA**, more stringent hazardous waste management standards, and a comprehensive underground storage tank (UST) program. (source: www.epa.gov/region5/defs/html/rcra.htm, accessed 3-7-05)

recharge – The process by which water is added to a zone of saturation (aquifer) from surface infiltration, typically when rainwater soaks through the earth to reach an aquifer.

recharge basin – A basin (natural or artificial) that collects water. The water will infiltrate to the aquifer.

release – Spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of a hazardous substance, pollutant, or contaminant into the environment. The National Contingency Plan also defines the term to include a threat of release.

rem – Stands for “roentgen equivalent man,” a unit by which human radiation dose is assessed (see also **Sv**). The rem is a risk-based value used to estimate the potential health effects to an exposed individual or population. 100 rem = 1 sievert.

remedial (or remediation) alternatives – Options considered under **CERCLA** for decontaminating a site such as an operable unit (**OU**) or area of concern (**AOC**). Remedial actions are long-term activities that prevent the possible release, or stop or substantially reduce the actual release, of substances that are hazardous but not immediately life-threatening. See also feasibility study (**FS**) and Record of Decision (**ROD**).

residual fuel – Crude oil, Nos. 1 and 2 fuel oil that have a nitrogen content greater than 0.05 weight percent, and all fuel oil Nos. 4, 5, and 6, as defined by the American Society of Testing and Materials in ASTM D396-78, *Standard Specifications for Fuel Oils*, (c. 2001).

riparian – An organism living on the bank of a river, lake, or tidewater.

ROD (Record of Decision) – A document that records a regulatory agency’s decision for the selected remedial action. The ROD also includes a responsiveness summary and a bibliography of documents that were used to reach the remedial decision. When the ROD is finalized, remedial design and implementation can begin.

roentgen – See **R**.

RPD (relative percent difference) – A measure of precision, expressed by the formula: $RPD = [(A-B)/(A+B)] \times 200$, where A equals the concentration of the first analysis and B equals the concentration of the second analysis.

runoff – The movement of water over land. Runoff can carry pollutants from the land into surface waters or uncontaminated land.

S

sampling – The extraction of a prescribed portion of an effluent stream or environmental media for purposes of inspection or analysis.

SARA (Superfund Amendments and Reauthorization Act) – This Act of Congress in 1986 reauthorized CERCLA to continue cleanup activities around the country. Several site-specific amendments, definitions clarifications, and technical requirements were added to the legislation, including additional enforcement authorities. Title III of SARA also authorized EPCRA. (source: www.epa.gov/region5/defs/html/sara.htm, accessed 3-7-05)

SBMS (Standards-Based Management System) – A document management tool used to develop and integrate systems, and to demonstrate BNL's conformance to requirements to perform work safely and efficiently.

scintillation – Flashes of light produced in a phosphor by a radioactive material.

SDWA (Safe Drinking Water Act) – The Safe Drinking Water Act was established to protect the quality of drinking water in the United States. It focuses on all waters actually or potentially designed for drinking use, whether from above ground or underground sources. The SDWA authorized EPA to establish safe standards of purity and required all owners or operators of public water systems to comply with health-related standards. State governments assume regulatory power from EPA. (source: www.epa.gov/region5/defs/html/sdwa.htm, accessed 3-7-05)

sediment – The layer of soil and minerals at the bottom of surface waters, such as streams, lakes, and rivers.

sensitivity – The minimum amount of an analyte that can be repeatedly detected by an instrument.

sievert – See Sv.

skyshine – Radiation emitted upward from an open-topped, shielded enclosure and reflected downward, resulting in the possibility that flora and fauna (including humans) outside the shielded enclosure can be exposed to radiation.

sludge – Semisolid residue from industrial or water treatment processes.

sole source aquifer – An area defined by EPA as being the primary source of drinking water for a particular region. Includes the surface area above the sole source aquifer and its recharge area.

SPDES (State Pollutant Discharge Elimination System) This permit program is delegated to the states, but the effluent limitations and other requirements are set by the federal government. 6 NYCRR Section 750-1.11(a) concerns the provisions of SPDES permits and lists the citations for the various effluent limitations from the Federal Register and the CFR. (source: www.dec.state.ny.us/website/dcs/spdes/spdes02.html, accessed 3-7-05)

stable – Nonradioactive.

stakeholder – People or organizations with vested interests

in BNL and its environment and operations. Stakeholders include federal, state, and local regulators; the public; DOE; and BNL staff.

stripping – A process used to remove volatile contaminants from a substance (see also **air stripping**).

sump – A pit or tank that catches liquid **runoff** for drainage or disposal.

Sv (sievert) – A unit for assessing the risk of human radiation dose, used internationally and with increasing frequency in the United States. One sievert is equal to 100 rem.

SVE (soil vapor extraction) – An *in situ* (in-place) method of extracting **VOCs** from soil by applying a vacuum to the soil and collecting the air, which can be further treated to remove the VOCs, or discharged to the atmosphere.

SVOC – A general term for volatile organic compounds that vaporize relatively slowly at standard temperature and pressure. See also **VOC**.

synoptic – Relating to or displaying conditions as they occur over a broad area.

T

$t_{1/2}$ (half-life) – The time required for one-half of the atoms of any given amount of a radioactive substance to disintegrate; the time required for the activity of a radioactive sample to be reduced by one half.

TCE (trichloroethylene, also known as trichloroethene) A stable, colorless liquid with a low boiling point. TCE has many industrial applications, including use as a solvent and as a metal degreasing agent. TCE may be toxic when inhaled or ingested, or through skin contact, and can damage vital organs, especially the liver. See also **VOC**.

Tier III reports – Reports, required by SARA, that are prepared to document annual emissions of toxic materials to the environment. These are also known as TRI Section 313 reports.

TLD (thermoluminescent dosimeter) – A device used to measure radiation dose to occupational workers or radiation levels in the environment.

tritium – The heaviest and only radioactive nuclide of hydrogen, with a **half-life** of 12.3 years and a very-low-energy radioactive decay (tritium is a **beta** emitter).

TSCA (Toxic Substances Control Act) – Enacted by Congress in 1976, TSCA empowers EPA to track the 75,000 industrial chemicals produced or imported into the United States. EPA repeatedly screens these chemicals and can require reporting or testing of any that may pose an environmental or human health hazard. EPA can ban the manufacture or import of chemicals that pose an unreasonable risk. (source: www.epa.gov/region5/defs/html/tasca.htm, accessed 3-7-05)

TVOC (total volatile organic compounds) – A sum of all individual **VOC** concentrations detected in a given sample.

U

UIC (underground injection control) – A hole with vertical dimensions greater than its largest horizontal dimensions; used for disposal of wastewater.

UST (underground storage tank) – A stationary device, constructed primarily of nonearthen material, designed to contain petroleum products or hazardous materials. In a UST, 10 percent or more of the volume of the tank system is below the surface of the ground.

upgradient/upslope – A location of higher **groundwater** elevation; analogous to “upstream.”

V

vadose – Relating to water in the ground that is above the permanent groundwater level.

vernal pool – A small, isolated, and contained basin that holds water on a temporary basis, most commonly during winter and spring. It has no aboveground outlet for water and is extremely important to the life cycle of many amphibians (such as the tiger salamander), as it is too shallow to support fish, a major predator of amphibian larvae.

VOC (volatile organic compound) – A general term for organic compounds capable of a high degree of vaporization at standard temperature and pressure. Because VOCs readily evaporate into the air, the potential for human exposure is greatly increased. Due to widespread industrial use, VOCs are commonly found in soil and groundwater.

VUV – Stands for “very ultraviolet” and refers to a beam-line at the NSLS with wavelengths at the far ultraviolet end of the spectrum.

W

waste minimization – Action that avoids or reduces the generation of waste, consistent with the general goal of minimizing current and future threats to human health, safety, and the environment. Waste minimization activities

include recycling, improving energy usage, reducing waste at the source, and reducing the toxicity of hazardous waste. This action is associated with pollution prevention, but is more likely to occur after waste has been generated.

water table – The water-level surface below the ground where the unsaturated zone ends and the saturated zone begins. It is the level to which a well that is screened in the unconfined aquifer will fill with water.

watershed – The region draining into a river, a river system, or a body of water.

weighting factor – A factor which, when multiplied by the dose equivalent delivered to a body organ or tissue, yields the equivalent risk due to a uniform radiation exposure of the whole body. *See also* **EDE**.

wet weight – The wet weight concentration of a substance is before a sample is dried for analysis (in other words, in its “natural” state), and is the form most likely to be consumed. Wet weight concentrations are typically lower than dry weight values.

wind rose – A diagram that shows the frequency of wind from different directions at a specific location.

X

x-rays – A form of electromagnetic **radiation** with short wavelength, generated when high-energy electrons strike matter or when lower-energy **beta** radiation is absorbed in matter. **Gamma** radiation and x-rays are identical, except for the source.

Z

zeolite – A naturally occurring group of more than 100 minerals, formed of silicates and aluminum, with unique and diverse crystal properties. Zeolites can perform ion exchange, filtering, odor removal, and chemical sieve and gas absorption tasks. Synthetic zeolites are now used for most applications.

Understanding Radiation

This section introduces the general reader to some basic concepts of radioactivity and an understanding of the radiation emitted as radioactive materials decay to a stable state. To better comprehend the radiological information in the Site Environmental Report (SER) it, is important to remember that not all radiations are the same and that different kinds of radiation affect living beings differently.

This appendix includes discussions on the common sources of radioactivity in the environment, types of radiation, the analyses used to quantify radioactive material, and how radiation sources contribute to radiation dose. Some general statistical concepts are also presented, along with a discussion of radionuclides that are of environmental interest at BNL. The discussion begins with some definitions and background information on scientific notation and numerical prefixes used when measuring dose and radioactivity. The definitions of commonly used radiological terms are found in the Technical Topics section of the glossary, Appendix A, and are indicated in boldface type here only when the definition in the glossary provides additional details.

RADIOACTIVITY AND RADIATION

All substances are composed of atoms that are made of subatomic particles: protons, neutrons, and electrons. The protons and neutrons are tightly bound together in the positively charged nucleus (plural: nuclei) at the center of the atom. The nucleus is surrounded by a cloud of negatively charged electrons. Most nuclei are stable because the forces holding the protons and neutrons together are strong enough to overcome the electrical energy that tries to push them apart. When the number of neutrons in the nucleus exceeds a threshold, then the nucleus becomes unstable and will spontaneously “decay,” or emit excess energy (“nuclear” energy) in the form of charged particles or electromagnetic waves. Radiation is the excess energy released by unstable atoms. Radioactivity and radioactive refer to the unstable nuclear property of a substance (e.g., radioactive uranium). When a charged particle or electromagnetic wave is detected by radiation-sensing equipment, this is referred to as a radiation event.

Radiation that has enough energy to remove electrons from atoms within material (a process called ionization) is classified as ionizing radiation. Radiation that does not have enough energy to remove electrons is called nonionizing radiation. Examples of nonionizing radiation include most visible light, infrared light, microwaves, and radio waves. All radiation, whether

ionizing or not, may pose health risks. In the SER, radiation refers to ionizing radiation.

Radioactive elements (or radionuclides) are referred to by name followed by a number, such as cesium-137. The number indicates the mass of that element and the total number of neutrons and protons contained in the nucleus of the atom. Another way to specify cesium-137 is Cs-137, where Cs is the chemical symbol for cesium in the Periodic Table of the Elements. This type of abbreviation is used in the SER.

SCIENTIFIC NOTATION

Most numbers used for measurement and quantification in the SER are either very large or very small, and many zeroes would be required to express their value. To avoid this, scientific notation is used, with numbers represented in multiples of 10. For example, the number two million five hundred thousand (two and a half million, or 2,500,000) is written in scientific notation as 2.5×10^6 , which represents “2.5 multiplied by (10 raised to the power of 6).” Since even “ 2.5×10^6 ” can be cumbersome, the capital letter E is substituted for the phrase “10 raised to the power of ...” Using this format, 2,500,000 is represented as 2.5E+06. The “+06” refers to the number of places the decimal point was moved to the left to create the shorter version. Scientific notation is also used to represent numbers smaller than zero, in which case a

Figure B-1. Typical Annual Radiation Doses from Natural and Man-Made Sources (mrem). Source: NCRP Report No. 93 (NCRP 1987)

minus sign follows the E rather than a plus. For example, 0.00025 can be written as 2.5×10^{-4} or $2.5\text{E-}04$. Here, “-04” indicates the number of places the decimal point was moved to the right.

NUMERICAL PREFIXES

Another method of representing very large or small numbers without using many zeroes is to use prefixes to represent multiples of ten. For example, the prefix milli (abbreviated m) means that the value being represented is one-thousandth of a whole unit; 3 mg (milligrams) is 3 thousandths of a gram or E-03. See Appendix C for additional common prefixes, including pico (p), which means trillionth or E-12, giga (G), which means billion or E+09, and tera (T), which means trillion, E+12.

SOURCES OF IONIZING RADIATION

Radiation is energy that has both natural and manmade sources. Some radiation is essential to life, such as heat and light from the sun. Exposure to high-energy (ionizing) radiation has to be managed, as it can pose serious health risks at large doses. Living things are exposed to radiation from natural background sources: the atmosphere, soil, water, food, and even our own bodies. Humans are exposed to ionizing radiation from a variety of common sources, the most significant of which follow.

Background Radiation – Radiation that occurs naturally in the environment is also called background activity. Background radiation consists

of cosmic radiation from outer space, radiation from radioactive elements in soil and rocks, and radiation from radon and its decay products in air. Some people use the term background when referring to all non-occupational sources commonly present. Other people use natural to refer only to cosmic and terrestrial sources, and background to refer to common man-made sources such as medical procedures, consumer products, and radioactivity present in the atmosphere from former nuclear testing. In the SER, the term natural background is used to refer to radiation from cosmic and terrestrial radiation.

Cosmic – Cosmic radiation primarily consists of charged particles that originate in space, beyond the earth’s atmosphere. This includes ionizing radiation from the sun, and secondary radiation generated by the entry of charged particles into the earth’s atmosphere at high speeds and energies. Radioactive elements such as hydrogen-3 (tritium), beryllium-7, carbon-14, and sodium-22 are produced in the atmosphere by cosmic radiation. Exposure to cosmic radiation increases with altitude, because at higher elevations the atmosphere and the earth’s magnetic field provide less shielding. Therefore, people who live in the mountains are exposed to more cosmic radiation than people who live at sea level. The average dose from cosmic radiation to a person living in the United States is approximately 26 mrem per year. (For an explanation of dose, see effective dose equivalent in Appendix A. The units rem and sieverts also are explained in Appendix A.)

Terrestrial – Terrestrial radiation is released by radioactive elements that have been present in the soil since the formation of the earth. Common radioactive elements that contribute to terrestrial exposure include isotopes of potassium, thorium, actinium, and uranium. The average dose from terrestrial radiation to a person living in the United States is approximately 28 mrem per year, but may vary considerably depending on the local geology.

Internal – Internal exposure occurs when radionuclides are ingested, inhaled, or absorbed through the skin. Radioactive material may be incorporated into food through the uptake of terrestrial radionuclides by plant roots. People can

ingest radionuclides when they eat contaminated plant matter or meat from animals that have consumed contaminated plants. The average dose from food for a person living in the United States is about 40 mrem per year. A larger exposure, for most people, comes from breathing the decay products of naturally occurring radon gas. The average dose from breathing air with radon byproducts is about 200 mrem per year, but that amount varies depending on geographical location. An EPA map shows that BNL is located in one of the regions with the lowest potential radon risk.

Medical – Every year in the United States, millions of people undergo medical procedures that use ionizing radiation. Such procedures include chest and dental x-rays, mammography, thallium heart stress tests, and tumor irradiation therapies. The average doses from nuclear medicine and x-ray examination procedures are about 14 and 39 mrem per year, respectively.

Anthropogenic – Sources of anthropogenic (man-made) radiation include consumer products such as static eliminators (containing polonium-210), smoke detectors (containing americium-241), cardiac pacemakers (containing plutonium-238), fertilizers (containing isotopes from uranium and thorium decay series), and tobacco products (containing polonium-210 and lead-210). The average dose from consumer products to a person living in the United States is 10 mrem per year (excluding tobacco contributions).

COMMON TYPES OF IONIZING RADIATION

The three most common types of ionizing radiation are described below.

Alpha Radiation – An alpha particle is identical in makeup to the nucleus of a helium atom, consisting of two neutrons and two protons. Alpha particles have a positive charge and have little or no penetrating power in matter. They are easily stopped by materials such as paper and have a range in air of only an inch or so. However, if alpha-emitting material is ingested, alpha particles can pose a health risk inside the body. Naturally occurring radioactive elements such as uranium emit alpha radiation.

Beta Radiation – Beta radiation is composed

of particles that are identical to electrons. Therefore, beta particles have a negative charge. Beta radiation is slightly more penetrating than alpha radiation, but most beta radiation can be stopped by materials such as aluminum foil and plexiglass panels. Beta radiation has a range in air of several feet. Naturally occurring radioactive elements such as potassium-40 emit beta radiation. Some beta particles present a hazard to the skin and eyes.

Gamma Radiation – Gamma radiation is a form of electromagnetic radiation, like radio waves or visible light, but with a much shorter wavelength. Gamma rays are emitted from a radioactive nucleus along with alpha or beta particles. Gamma radiation is more penetrating than alpha or beta radiation, capable of passing through dense materials such as concrete. Gamma radiation is identical to x-rays except that x-rays are more energetic. Only a fraction of the total gamma rays a person is exposed to will interact with the human body.

TYPES OF RADIOLOGICAL ANALYSES

The amount of radioactive material in a sample of air, water, soil, or other material can be assessed using several analyses, the most common of which are described below.

Gross alpha – Alpha particles are emitted from radioactive material in a range of different energies. An analysis that measures all alpha particles simultaneously, without regard to their particular energy, is known as a gross alpha activity measurement. This type of measurement is valuable as a screening tool to indicate the total amount but not the type of alpha-emitting radionuclides that may be present in a sample.

Gross beta – This is the same concept as that for gross alpha analysis, except that it applies to the measurement of gross beta particle activity.

Tritium – Tritium radiation consists of low-energy beta particles. It is detected and quantified by liquid scintillation counting. More information on tritium is presented in the section Radionuclides of Environmental Interest, later in this appendix.

Strontium-90 – Due to the properties of the radiation emitted by strontium-90 (Sr-90), a special analysis is required. Samples are

chemically processed to separate and collect any strontium atoms that may be present. The collected atoms are then analyzed separately. More information on Sr-90 is presented in the section Radionuclides of Environmental Interest.

Gamma – This analysis technique identifies specific radionuclides. It measures the particular energy of a radionuclide’s gamma radiation emission. The energy of these emissions is unique for each radionuclide, acting as a “fingerprint” to identify it.

STATISTICS

Two important statistical aspects of measuring radioactivity are uncertainty in results, and negative values.

Uncertainty – Because the emission of radiation from an atom is a random process, a sample counted several times usually yields a slightly different result each time; therefore, a single measurement is not definitive. To account for this variability, the concept of uncertainty is applied to radiological data. In the SER, analysis results are presented in an $x \pm y$ format, where “x” is the analysis result and “ $\pm y$ ” is the 95 percent “confidence interval” of that result. That means there is a 95 percent probability that the true value of x lies between $(x + y)$ and $(x - y)$.

Negative values – There is always a small amount of natural background radiation. The laboratory instruments used to measure radioactivity in samples are sensitive enough to measure the background radiation along with any contaminant radiation in the sample. To obtain a true measure of the contaminant level in a sample, the background radiation level must be subtracted from the total amount of radioactivity measured. Due to the randomness of radioactive emissions and the very low concentrations of some contaminants, it is possible to obtain a background measurement that is larger than the actual contaminant measurement. When the larger background measurement is subtracted from the smaller contaminant measurement, a negative result is generated. The negative results are reported, even though doing so may seem illogical, because they are essential when conducting statistical evaluations of data.

Radiation events occur randomly; if a radioactive sample is counted multiple times, a spread, or distribution, of results will be obtained. This spread, known as a Poisson distribution, is centered about a mean (average) value. Similarly, if background activity (the number of radiation events observed when no sample is present) is counted multiple times, it also will have a Poisson distribution. The goal of a radiological analysis is to determine whether a sample contains activity greater than the background reading detected by the instrument. Because the sample activity and the background activity readings are both Poisson distributed, subtraction of background activity from the measured sample activity may result in values that vary slightly from one analysis to the next. Therefore, the concept of a minimum detection limit (MDL) was established to determine the statistical likelihood that a sample’s activity is greater than the background reading recorded by the instrument.

Identifying a sample as containing activity greater than background, when it actually does not have activity present, is known as a Type I error. Most laboratories set their acceptance of a Type I error at 5 percent when calculating the MDL for a given analysis. That is, for any value that is greater than or equal to the MDL, there is 95 percent confidence that it represents the detection of true activity. Values that are less than the MDL may be valid, but they have a reduced confidence associated with them. Therefore, all radiological data are reported, regardless of whether they are positive or negative.

At very low sample activity levels that are close to the instrument’s background reading, it is possible to obtain a sample result that is less than zero. This occurs when the background activity is subtracted from the sample activity to obtain a net value, and a negative value results. Due to this situation, a single radiation event observed during a counting period could have a significant effect on the mean (average) value result. Subsequent analysis may produce a sample result that is positive. When the annual data for the SER are compiled, results may be averaged; therefore, all negative values are retained for reporting as

well. This data handling practice is consistent with the guidance provided in the Handbook of Radioactivity Measurements Procedures (NCRP 1985) and the Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance (DOE 1991). Average values are calculated using actual analytical results, regardless of whether they are above or below the MDL, or even equal to zero. The uncertainty of the mean, or the 95 percent confidence interval, is determined by multiplying the population standard deviation of the mean by the $t_{(0.05)}$ statistic.

RADIONUCLIDES OF ENVIRONMENTAL INTEREST

Several types of radionuclides are found in the environment at BNL due to historical operations.

Cesium-137 – Cs-137 is a fission-produced radionuclide with a half-life of 30 years (after 30 years, only one half of the original activity level remains). It is found in the worldwide environment as a result of past aboveground nuclear weapons testing and can be observed in near-surface soils at very low concentrations, usually less than 1 pCi/g (0.004 Bq/g). Cs-137 is a beta-emitting radionuclide, but it can be detected by gamma spectroscopy because its decay product, barium-137m, emits gamma radiation.

Cs-137 is found in the environment at BNL mainly as a soil contaminant, from two main sources. The first source is the worldwide deposition from nuclear accidents and fallout from weapons testing programs. The second source is deposition from spills or releases from BNL operations. Nuclear reactor operations produce Cs-137 as a byproduct. In the past, wastewater containing small amounts of Cs-137 generated at the reactor facilities was routinely discharged to the Sewage Treatment Plant (STP), resulting in low-level contamination of the STP and the Peconic River. In 2002/2003, under the Environmental Restoration Program, sand and its debris containing low levels of Cs-137, Sr-90, and heavy metals were removed, assuring that future discharges from the STP are free of these contaminants. Soil contaminated with

Cs-137 is associated with the following areas that have been, or are being, addressed as part of the Environmental Remediation Program: former Hazardous Waste Management Facility, Waste Concentration Facility, Building 650 Reclamation Facility and Sump Outfall Area, and the Brookhaven Graphite Research Reactor (BGRR).

Strontium-90 – Sr-90 is a beta-emitting radionuclide with a half-life of 28 years. Sr-90 is found in the environment principally as a result of fallout from aboveground nuclear weapons testing. Sr-90 released by weapons testing in the 1950s and early 1960s is still present in the environment today. Additionally, nations that were not signatories of the Nuclear Test Ban Treaty of 1963 have contributed to the global inventory of fission products (Sr-90 and Cs-137). This radionuclide was also released as a result of the 1986 Chernobyl accident in the former Soviet Union.

Sr-90 is present at BNL in the soil and groundwater. As in the case of Cs-137, some Sr-90 at BNL results from worldwide nuclear testing; the remaining contamination is a by-product of reactor operations. The following areas with Sr-90 contamination have been or are being addressed as part of the Environmental Remediation Program: former Hazardous Waste Management Facility, Waste Concentration Facility, Building 650 Reclamation Facility and Sump Outfall Area, the BGRR, Former and Interim Landfills, Chemical and Glass Holes Area, and the STP.

The information in SER tables is arranged by method of analysis. Because Sr-90 requires a unique method of analysis, it is reported as a separate entry. Methods for detecting Sr-90 using state-of-the-art equipment are quite sensitive (detecting concentrations less than 1 pCi/L), which makes it possible to detect background levels of Sr-90.

Tritium – Among the radioactive materials that are used or produced at BNL, tritium has received the most public attention. Approximately 4 million Ci (1.5×10^5 TBq) per year are produced in the atmosphere naturally (NCRP 1979). As a result aboveground weapons testing in the 1950s and early 1960s in the United

States, the global atmospheric tritium inventory was increased by a factor of about 200. Other human activities such as consumer product manufacturing and nuclear power reactor operations have also released tritium into the environment. Commercially, tritium is used in products such as self-illuminating wristwatches and exit signs (the signs may each contain as much as 25 Ci [925 GBq] of tritium). Tritium also has many uses in medical and biological research as a labeling agent in chemical compounds, and is frequently used in universities and other research settings such as BNL and the other national laboratories.

Of the sources mentioned above, the most significant contributor to tritium in the environment has been aboveground nuclear weapons testing. In the early 1960s, the average tritium concentration in surface streams in the United States reached a value of 4,000 pCi/L (148 Bq/L; NCRP 1979). Approximately the same concentration was measured in precipitation. Today, the level of tritium in surface waters in New York State is less than one-twentieth of that amount, below 200 pCi/L (7.4 Bq/L; NYSDOH 1993). This is less than the detection limit of most analytical laboratories.

Tritium has a half-life of 12.3 years. When an atom of tritium decays, it releases a beta particle, causing transformation of the tritium atom into stable (nonradioactive) helium. The beta radiation that tritium releases has a very low energy, compared to the emissions of most other radioactive elements. In humans, the outer layer of dead skin cells easily stops the beta radiation from tritium; therefore, only when tritium is taken into the body can it cause an exposure. Tritium may be taken into the body by inhalation, ingestion, or absorption of tritiated water through the skin. Because of its low energy radiation and short residence time in the body, the health threat posed by tritium is very small for most exposures.

Environmental tritium is found in two forms: gaseous elemental tritium, and tritiated water or water vapor, in which at least one of the hydrogen atoms in the H₂O water molecule

has been replaced by a tritium atom (hence, its shorthand notation, HTO). Most of the tritium released from BNL sources is in the form of HTO, none as elemental tritium. Sources of tritium at BNL include the reactor facilities (all now non-operational), where residual water (either heavy or light) is converted to tritium via neutron bombardment; the accelerator facilities, where tritium is produced by secondary radiation interactions with soil and water; and facilities like the Brookhaven Linac Isotope Producer (BLIP), where tritium is formed from secondary radiation interaction with cooling water. Tritium has been found in the environment at BNL as a groundwater contaminant from operations in the following areas: Current Landfill, BLIP, Alternating Gradient Synchrotron, and the High Flux Beam Reactor. Although small quantities of tritium are still being released to the environment through BNL emissions and effluents, the concentrations and total quantity have been drastically reduced, compared with historical operational releases as discussed in Chapters 4 and 5.

REFERENCES AND BIBLIOGRAPHY

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APPENDIX C

Units of Measure and Half-Life Periods

UNITS OF RADIATION MEASUREMENT AND CONVERSIONS

U.S. System	International System	Conversion
curie (Ci)	becquerel (Bq)	1 Ci = 3.7×10^{10} Bq
rad	gray (Gy)	1 rad = 0.01 Gy
rem	sievert (Sv)	1 rem = 0.01 Sv

APPROXIMATE METRIC CONVERSIONS

When you know	multiply by	to obtain	When you know	multiply by	to obtain
centimeters (cm)	0.39	inches (in.)	in.	2.54	cm
meters (m)	3.28	feet (ft)	ft	0.305	m
kilometers (km)	0.62	miles (mi)	mi	1.61	km
kilograms (kg)	2.20	pounds (lb)	lb	0.45	kg
liters (L)	0.264	gallons (gal)	gal	3.785	L
cubic meters (m ³)	35.32	cubic feet (ft ³)	ft ³	0.03	m ³
hectares (ha)	2.47	acres	acres	0.40	ha
square kilometers (km ²)	0.39	square miles (mi ²)	mi ²	2.59	km ²
degrees Celcius (°C)	1.8 (°C) + 32	degrees Fahrenheit (°F)	°F	(°F - 32) / 1.8	°C

SCIENTIFIC NOTATION USED FOR MEASUREMENTS

Multiple	Decimal Equivalent	Notation	Prefix	Symbol
1×10^{12}	1,000,000,000,000	E+12	Tera-	T
1×10^9	1,000,000,000	E+9	giga-	G
1×10^3	1,000	E+03	kilo-	k
1×10^{-2}	0.01	E-02	centi-	c
1×10^{-3}	0.001	E-03	milli-	m
1×10^{-6}	0.000001	E-06	micro-	μ
1×10^{-9}	0.000000001	E-09	nano-	n
1×10^{-12}	0.000000000001	E-12	pico-	p

CONCENTRATION CONVERSIONS

1 ppm = 1,000 ppb
1 ppb = 0.001 ppm = 1 μg/L*
1 ppm = 1 mg/L = 1000 μg/L*

* For aqueous fractions only.

HALF-LIFE PERIODS	
Am-241	432.7 yrs
C-11	~20 min
Co-60	5.3 yrs
Cs-137	30.2 yrs
N-13	~10 min
N-22	2.6 yrs
O-15	~2 min
PU-238	87.7 yrs
Pu-239	24,100.0 yrs
Pu-240	6,560.0 yrs
Sr-90	29.1 yrs
tritium	12.3 yrs
U-234	247,000.0 yrs
U-235	~700 million yrs (7.0004E8)
U-238	87.7 yrs

Federal, State, and Local Laws and Regulations Pertinent to BNL

DOE DIRECTIVES, REGULATIONS, AND STANDARDS

DOE O 231.1-A	Order: Environment, Safety and Health Reporting	08/19/03
DOE O 414.1	Order: Management Assessment and Independent Assessor's Guide	05/31/2001
DOE O 435.1	Order, Change 1: Radioactive Waste Management	08/28/2001
DOE O 450.1	Order: Environmental Protection Program	01/15/2003
DOE P 450.5	Policy: Line Environment, Safety, and Health Oversight	06/26/1997
DOE O 5400.5	Order: Change 2, Radiological Protection of the Public and the Environment	01/07/1993

FEDERAL LAWS AND REGULATIONS

Executive Order 13148 Greening of the Government Through Leadership in Environmental Management

10 CFR 1021	National Environmental Protection Act, Implementing and Procedures
10 CFR 1022	Compliance with Floodplain/Wetlands Environmental Review Requirements
10 CFR 830	Subpart A: Quality Assurance Requirements
10 CFR 834	Radiation Protection of the Public and the Environment
16 USC 470	National Historic Preservation Act
36 CFR 60	National Register of Historic Places
36 CFR 63	Determination of Eligibility for Inclusion in the National Register of Historic Places
36 CFR 79	Curation of Federally Owned and Administered Archaeological Collections
36 CFR 800	Protection of Historic Properties
40 CFR 50-0	National Primary and Secondary Ambient Air Quality Standards
40 CFR 82	Protection of Stratospheric Ozone
40 CFR 109	Criteria for State, Local and Regional Oil Removal Contingency Plans
40 CFR 110	Discharge of Oil
40 CFR 112	Oil Pollution Prevention
40 CFR 113	Liability Limits for Small Onshore Storage Facilities
40 CFR 116	Designation of Hazardous Substances
40 CFR 117	Determination of Reportable Quantities for Hazardous Substances
40 CFR 121	State Certification of Activities Requiring a Federal License or Permit

APPENDIX D: FEDERAL, STATE, AND LOCAL LAWS
AND REGULATIONS PERTINENT TO BNL

40 CFR 122	National Pollution Discharge Elimination System (NPDES)
40 CFR 123	State Program Requirements
40 CFR 124	Procedures for Decision-making
40 CFR 125	Criteria and Standards for the ...NPDES
40 CFR 129	Toxic Pollutant Effluent Standards
40 CFR 130	Water Quality Planning and Management
40 CFR 131	Water Quality Standards
40 CFR 132	Water Quality Guidance for the Great Lakes System
40 CFR 133	Secondary Treatment Regulation
40 CFR 135	Prior Notice of Citizen Suits
40 CFR 136	Guidelines Establishing Test Procedures for the Analysis of Pollutants
40 CFR 141	National Primary Drinking Water Regulations
40 CFR 142	National Primary Drinking Water Regulations Implementation
40 CFR 143	National Secondary Drinking Water Regulations
40 CFR 144	Underground Injection Control (UIC) Program
40 CFR 146	Underground Injection Control (UIC) Program: Criteria and Standards
40 CFR 148	Hazardous Waste Injection Restrictions
40 CFR 149	Sole Source Aquifers
40 CFR 167	... Submissions of Pesticide Reports
40 CFR 168	Statements of Enforcement Policies and Interpretations
40 CFR 169	Books and Records of Pesticide Production and Distribution
40 CFR 170	Worker Protection Standard
40 CFR 171	Certification of Pesticide Applicators
40 CFR 260	Hazardous Waste Management Systems: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste... Facilities
40 CFR 265	Interim ... Standards for ... Owners and Operators of Hazardous Waste ... Facilities
40 CFR 266	Standards for the Management of Special Hazardous ... Waste Management Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 270	EPA Administered Permit Program: The Hazardous Waste Permit Program

40 CFR 271	Requirements for Authorization of State Hazardous Waste Mgmt Programs
40 CFR 272	Approved State Hazardous Waste Management Programs
40 CFR 273	Standards for Universal Waste Management
40 CFR 279	Standards for the Management of Used Oil
40 CFR 280	Technical Standards ... Required for ...Operators of Underground Storage Tanks (USTs)
40 CFR 300	National Oil and Hazardous Substances Pollution Contingency Plan
40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 355	Emergency Planning and Notification
40 CFR 370	Hazardous Chemical Report: Community Right-to-Know
40 CFR 372	Toxic Chemical Release Report: Community Right-to-Know
40 CFR 700	Toxic Substances Control Act [TSCA]
40 CFR 702	Toxic Substances Control Act: General Practices and Procedures
40 CFR 704	Toxic Substances Control Act: Reporting & Recordkeeping Requirements
40 CFR 707	Chemical Imports and Exports
40 CFR 710	Inventory Reporting Regulations
40 CFR 712	Chemical Information Rules
40 CFR 716	Health and Safety Data Reporting
40 CFR 717	Records and Reports of ... Significant Adverse Reactions to Health or the Environment
40 CFR 720	Premanufacture Notification
40 CFR 721	Significant New Users of Chemical Substances
40 CFR 723	Premanufacture Notification Exemptions
40 CFR 725	Reporting Requirements and Review Processes for Microorganisms
40 CFR 745	Lead-Based Paint Poisoning Prevention in Certain Residential Structures
40 CFR 747	Metalworking Fluids
40 CFR 749	Water Treatment Chemicals
40 CFR 750	Procedures for Rulemaking Under Section 6 of TSCA
40 CFR 761	PCBs Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
40 CFR 763	Asbestos
40 CFR 1500	Council on Environmental Quality: Purpose, Policy, and Mandate
40 CFR 1501	NEPA and Agency Planning
40 CFR 1502	Environmental Impact Statement
40 CFR 1503	Commenting

APPENDIX D: FEDERAL, STATE, AND LOCAL LAWS AND REGULATIONS PERTINENT TO BNL

40 CFR 1504	Predecision Referrals to the Council of Proposed Federal Actions
40 CFR 1505	NEPA and Agency Decision-making
40 CFR 1506	Other Requirements of NEPA
40 CFR 1507	Agency Compliance
40 CFR 1508	Terminology and Index
50 CFR 17	Endangered and Threatened Wildlife and Plants

NEW YORK STATE LAWS, REGULATIONS, AND STANDARDS

6 NYCRR 182	Endangered and Threatened Species of Fish and Wildlife, Species of Special Concern
6 NYCRR 200	Environmental Conservation Law
6 NYCRR 201	Subpart 201-1: General Provisions
6 NYCRR 202	Subpart 202: Emissions Verification
6 NYCRR 203	Indirect Sources of Air Contamination
6 NYCRR 204	NO _x Budget Training Program
6 NYCRR 205	Architectural and Maintenance (AIM) Coatings
6 NYCRR 207	Control Measures for an Air Pollution Episode
6 NYCRR 208	Landfill Gas Collection and Control System for Certain Municipal Solid Waste Landfills
6 NYCRR 211	General Prohibitions
6 NYCRR 212	General Process Emission Sources
6 NYCRR 215	Open Fires
6 NYCRR 217	Environmental Conservation Rules and Regulations [Exhaust and Emission Standards]
6 NYCRR 218	Subpart 218-1 [More on Vehicle Exhaust]
6 NYCRR 221	Asbestos-Containing Surface Coating Material
6 NYCRR 225	Subpart 225-1: Fuel Composition and Use – Sulfur Limitations
6 NYCRR 227	Solvent Metal Cleaning Processes
6 NYCRR 228	Surface Coating Processes
6 NYCRR 229	Petroleum and Volatile Organic Liquid Storage and Transfer
6 NYCRR 230	Gasoline Dispensing Sites and Transport Vehicles
6 NYCRR 231	New Source Review in Nonattainment Areas and Ozone Transport Regions
6 NYCRR 234	Graphic Arts
6 NYCRR 237	Acid Deposition Reduction NO _x Budget Training Program
6 NYCRR 238	Acid Deposition Reduction SO ₂ Budget Training Program

6 NYCRR 239	Portable Fuel Container Spillage Control
6 NYCRR 240	Conformity to State or Federal Implementation Plans
6 NYCRR 250	Miscellaneous Orders
6 NYCRR 256	Air Quality Classification System
6 NYCRR 257	Air Quality Standards
6 NYCRR 307	[Air Quality in] Suffolk County
6 NYCRR 320	Pesticides - General
6 NYCRR 325	Application of Pesticides
6 NYCRR 326	Registration and Certification of Pesticides
6 NYCRR 327	Use of Chemicals for the Control or Elimination of Aquatic Vegetation
6 NYCRR 328	Use of Chemicals for the Extermination of Undesirable Fish
6 NYCRR 329	Use of Chemicals for the Control or Elimination of Aquatic Insects
6 NYCRR 360-1	General Provisions: Reg. Solid Waste Management Facility
6 NYCRR 361	Siting of Industrial Hazardous Waste Facilities
6 NYCRR 364	Waste Transporter Permits
6 NYCRR 370	Hazardous Waste Management Regulations
6 NYCRR 371	Identification and Listing of Hazardous Waste
6 NYCRR 372	Hazardous Waste Manifest Systems and ... Standards for Generators... and Facilities
6 NYCRR 373	Hazardous Waste Management Facilities
6 NYCRR 374	Standards for the Management of Specific Hazardous Wastes
6 NYCRR 376	Land Disposal Restrictions
6 NYCRR 595	Release of Hazardous Substances
6 NYCRR 596	Hazardous Substance Bulk Storage Regulations
6 NYCRR 597	List of Hazardous Substances
6 NYCRR 611	Environmental Priorities & Procedures in Petroleum Cleanup & Removal
6 NYCRR 612	Registration of Petroleum Storage Facilities
6 NYCRR 613	Handling and Storage of Petroleum
6 NYCRR 663	Freshwater Wetlands Permit Requirements
6 NYCRR 666	Regulations for ... the Wild, Scenic, and Recreational Rivers System in NYS...
6 NYCRR 700	Part 700 Water Quality Regulations
6 NYCRR 701	Classification – Surface Waters and Groundwaters
6 NYCRR 702	Derivation and Use of Standards and Guidance Values

APPENDIX D: FEDERAL, STATE, AND LOCAL LAWS
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6 NYCRR 703 Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations

6 NYCRR 750 Obtaining a SPDES Permit

10 NYCRR 5 State Sanitary Code – Part 5

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2004 Site Environmental Report Reader Response Form

The 2004 Site Environmental Report (SER) was written to inform outside regulators, the public, and BNL employees of the Laboratory's environmental performance for the calendar year. The report summarizes BNL's on-site environmental data; environmental management performance; compliance with applicable regulations; and environmental, restoration, and surveillance monitoring programs.

BNL welcomes your comments, suggestions for improvements, or any questions you may have. Please fill in the information below, and mail your response form to:

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Environmental and Waste Management Services Division
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