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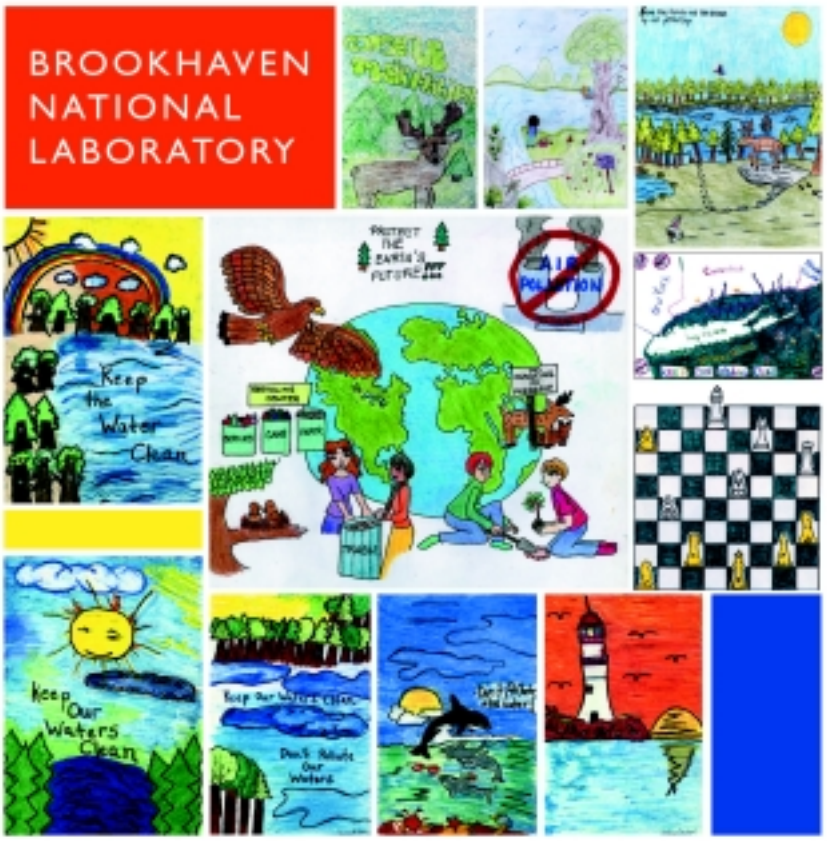


# Site Environmental Report 2000

September 2001

Prepared by
Brookhaven Science Associates, LLC
For the U.S. Department of Energy
Under Contract No. DE-AC02-98CH10886

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Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

PRINTED ON POST-CONSUMER RECYCLED PAPER

# *A Message*

from the Laboratory Director

Brookhaven National Laboratory operates on more than 5,000 acres of the diverse and lovely environment of eastern Long Island. Our environmental reach, however, extends far beyond that. We exert our broader influence not only through the basic and applied research we perform, but also through the example we set in managing our own environment. As Laboratory Director, I take this responsibility for environmental stewardship very seriously.

The Laboratory is beginning to see results from the major commitments we have made to protect our environment. We now have nine facilities with Environmental Management Systems registered under the prestigious ISO 14001 standard, and expect to have Labwide registration by the summer of 2001. We continue to increase our recycling efforts and reduce our generation of routine wastes. In 2000, the Laboratory collected over 336 tons of paper for recycling; and from 1993-2000, we reduced routine hazardous waste generation by 81%, mixed waste by 67%, and radioactive waste by 57%. We have seen continued improvements in our compliance and a significant reduction in our environmental vulnerabilities. The 530-acre Upton Ecological and Research Reserve was dedicated in November 2000 and will support ecological research and habitat enhancement.

Brookhaven National Laboratory continues to address historical issues under an ongoing Facility Review Project and the large scale Environmental Restoration Program. I am committed to an expedited cleanup of our site as well as stewardship of our natural resources. Our Groundwater Protection Program focuses on preventing impacts to groundwater and restoring groundwater quality.

The Laboratory is openly communicating with neighbors, regulators, employees, and other interested parties on environmental issues and progress. We realize that we must continue to deliver on our commitments and set in place a permanent environmental stewardship strategy for the Laboratory. As we continue to demonstrate improvements in our environmental performance, we are regaining the trust of our regulators and neighbors. I am proud to be able to say that we are conducting world-class research in an environmentally responsible manner.

John H. Marburger

John H. Marburger, *Laboratory Director*

Keep Our Waters Clean
Don't Pollute
Our
Waters

# *Executive Summary*

Brookhaven National Laboratory (BNL) strives for excellence in both its science research and its facility operations. BNL manages its world-class scientific research with particular sensitivity to environmental and community issues through its internationally recognized Environmental Management System (EMS) and award-winning community relations program. The *Site Environmental Report 2000* (SER) summarizes the status of the Laboratory's environmental programs and performance, including the steady progress towards cleaning up the Laboratory site and fully integrating environmental stewardship into all facets of BNL's mission. BNL's motto, "Exploring Earth's Mysteries... Protecting its Future," describes how the Laboratory approaches its work, with balance between science and the environment.

One of the newest initiatives at the Laboratory, the Upton Ecological and Research Reserve, will permanently preserve 530 acres (212 hectares) of the Long Island Central Pine Barrens, a unique ecosystem of forests and wetlands. The Reserve sets aside 10% of BNL property for conservation and ecological research through a partnership between the U.S. Department of Energy (DOE) and the U.S. Fish and Wildlife Service. The Reserve provides habitat for approximately 27 endangered, threatened, or species of special concern, including the state-endangered eastern tiger salamander, state-threatened banded sunfish, and swamp darter, along with a number of other species found onsite, such as the wild turkey and red-tailed hawk.

### ENVIRONMENTAL PROGRAMS

BNL continues to implement an EMS consistent with the International Organization for Standardization ISO 14001, with increased emphasis on compliance assurance, pollution prevention, and community outreach. The goal of BNL's EMS is to ensure that programs are managed in an environmentally responsible manner in order to protect the ecosystem and human health. In 1999, the Relativistic Heavy Ion Collider became the first Long Island-based organization and the first DOE Office of Science facility to achieve ISO 14001 registration. In September 2000, eight other BNL facilities were registered, with plans for the balance of the Laboratory to achieve registration by June 2001.

The Laboratory's Pollution Prevention/ Waste Minimization Program is an essential facet of the EMS. The BNL pollution prevention program goes beyond DOE pollution prevention goals, and represents an ongoing effort to make pollution prevention and waste minimization an integral part of the BNL operating philosophy. In 2000, BNL reduced, reused, or recycled more than 1,683 tons (1,527 metric tons) of hazardous, radioactive, and industrial wastes; reduced its overall water use by 63.5 million gallons (240 million liters); and used 26% less energy per square foot than in 1985. In total, pollution prevention projects saved over $2 million during the year.

The Facility Review Disposition Project ranks, schedules, and dispositions environmental issues identified during the 1997 review of all facilities at BNL. By the end of the calendar year, 130 of the top priority issues were resolved, and efforts to close the remaining issues in a prioritized manner continue.

### COMPLIANCE WITH ENVIRONMENTAL REGULATIONS

BNL is subject to more than 50 sets of federal, state, and local environmental regulations, 65 site-specific permits, and a number of other binding agreements. The Laboratory is committed to achieving and maintaining full compliance with these environmental requirements and agreements. In 2000, BNL operated in compliance with the majority of these requirements, and programs are in place to address areas for improvement. Emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide were all within permit limits. With the exception of 11 minor instances of State Pollutant Discharge Elimination System nonconformance, all discharges complied with

BNL's permit limits during 2000. Sixteen reportable spills occurred. All but four involved less than ten gallons, and all were cleaned up to the satisfaction of the New York State Department of Environmental Conservation. Two other reportable spills of hazardous materials (photographic materials and mercury) were cleaned up immediately.

BNL operations and environmental protection programs were extensively reviewed and audited by outside organizations in 2000. External audits in 2000 included the New York State Department of Environmental Conservation review of petroleum storage, hazardous waste, and air emissions from the Central Steam Facility. BNL took immediate corrective actions in response to a Notice of Violation issued by the state after the hazardous waste inspection. Several minor issues were identified at the Major Petroleum Facility and corrective actions are being taken. The Suffolk County Department of Health Services conducted routine site inspections, quarterly inspections of the Sewage Treatment Plant, and the annual potable water system inspection. The Laboratory's potable water system met all drinking water standards. Comprehensive evaluations conducted by an independent ISO 14001 registrar and DOE headquarters verified and validated the adequacy of BNL's Environmental and Integrated Safety Management Systems.

#### ENVIRONMENTAL MONITORING

The Laboratory maintains a comprehensive environmental monitoring system, including air monitoring stations, river water checkpoints, and a network of 683 groundwater monitoring wells. The monitoring system provides information to ensure compliance and for early detection and correction of unexpected conditions.

During 2000, BNL collected and analyzed over 6,000 sampling events. That number does not include samples taken to characterize wastes for disposal purposes or nonroutine samples collected in support of environmental restoration characterization activities. Fourteen groundwater plumes, including four plumes identified under BNL's comprehensive groundwater monitoring improvements project, were tracked, evaluated, and remediated as necessary.

In 2000, the Brookhaven Medical Research Reactor, the High Flux Beam Reactor, and the Brookhaven Linear Accelerator Isotope Producer were the most significant contributors to the site's radiological air emissions. Total radionuclide emissions were consistent with those of recent years. Total air emissions and radiological air quality met Clean Air Act and DOE standards. Due to rising natural gas prices, the Central Steam Facility relied more on fuel oil to meet the heating and cooling of BNL's major facilities than in 1999. As a result, annual facility emissions of particulate matter, nitrogen oxides, and sulfur dioxide increased, although they remained below 1996 levels and were well below permit limits.

#### ENVIRONMENTAL RESTORATION

During 2000, the Environmental Restoration Program excavated and shipped 2,640 cubic yards (2020 cubic meters) of radiologically contaminated landscape soils and 1,100 cubic yards (841 cubic meters) of PCB-contaminated soil to licensed offsite disposal facilities. This radiological contamination was the result of historical use of soils that had been removed from a former onsite waste storage facility and used as landscaping fill, while the PCB contamination originated from leaking drums in this former drum storage area. Another 1,000 cubic yards (764 cubic meters) of soil and debris from the glass holes excavation was shipped offsite for disposal.

BNL completed construction and testing of a new onsite groundwater treatment system located in a former scrap yard and drum storage area. During 2000, six groundwater remediation systems removed approximately 700 pounds (318 kg) of volatile organic compounds and returned approximately 1.0 billion gallons (3.8 billion liters) of treated water to the Upper Glacier aquifer. Approval of the Operable Unit III Record of Decision in June 2000 cleared the way for the construction of additional treatment systems on and off Laboratory property.

Decommissioning of the Brookhaven Graphite Research Reactor continued in 2000 with the removal of large cooling fans, the Pile Fan Sump, and associated contaminated soils. This research reactor operated from 1950 – 1969, and is now being addressed as part of a nationwide DOE effort to clean up legacy waste.

## RADIOLOGICAL DOSE ASSESSMENT

There was minimal radiological dose impact above natural background levels to the members of the public and the environment from BNL operations. The ambient external doses measured on the BNL site and in the neighboring area were very similar to each other. The hypothetical maximally exposed individual, defined as residing at the northeast boundary of BNL, breathing the air, and consuming 15 pounds of fish and 64 pounds of deer meat from onsite sources would receive 3.28 mrem/yr (32.8 μSv) of the total effective dose equivalent from inhalation and ingestion pathways. This is an extremely unlikely worst case scenario, but was calculated to show that the dose from all pathways would still be less than 4% of 100 mrem/yr dose limit set by DOE for the general public. The average annual dose from man-made, cosmic, terrestrial and ingestion paths, and radon is 360 mrem (3,600 μSv). Therefore, radioactive dose to the public from BNL activities is minimal.

Various remediation projects that had the potential to discharge radionuclides into the air in excess of 1% of the National Emissions Standard for Air Pollutants were also evaluated as diffuse sources. Although engineering and other radiation protection controls were implemented, an evaluation for NESHAPs was completed and the emissions were treated as continuous sources. There were five projects that fell under this category and the cumulative effective dose equivalent from all sources was 0.11 mrem (1.1 μSv).

This year's dose to the aquatic and terrestrial biota was also evaluated and no radiological doses to the aquatic animals, terrestrial plants, or terrestrial animals were recorded from BNL operations.

## QUALITY ASSURANCE

The BNL Analytical Services Laboratory performs approximately 5,000 radiological and nonradiological (chemical) analyses per year on environmental samples, and administers contracts with four offsite contractor laboratories. All laboratories are certified by New York State for the tests they perform for BNL. Quality control is maintained through daily instrument calibration, efficiency, background checks, and testing for precision and accuracy. The two primary laboratories reporting radiological analytical data each scored between 89% and 96% satisfactory results in both state and federal performance evaluation programs. For nonradiological performance evaluation testing, the Analytical Services Laboratory and the three contractor laboratories each scored over 92% in the 2000 New York State Environmental Laboratory Approval Program evaluations.

## OUTREACH AND COMMUNICATION

BNL conducted a number of public outreach activities including: presentations and meetings with the public; regular communications with the local, state, federal regulators, and elected officials; and routine interactions with the business and educational community. In 2000, BNL hosted more than 35,000 including visitors to the Laboratory through its Summer Sunday program. To highlight BNL's commitment to environmental stewardship, the Environmental Services Division organized a week long series of activities including presentations, contests, recycling demonstrations, and a four-mile race through the pine barrens onsite.

## CONCLUSION

The last three years have been a turning point for BNL and this Site Environmental Report documents the progress BNL continues to make in achieving its environmental stewardship goals. The Laboratory is focusing on conducting world-class research in an environmentally responsible manner, while cleaning up and restoring the environment.

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# *Acknowledgments*

The production of the BNL *Site Environmental Report 2000* (SER) requires the knowledge, skill, experience, and cooperation of many people and organizations at the Laboratory. Responsibility for producing the SER is with the Environmental Services Division, which is managed by Lori Cunniff. The lead authors, co-authors, and other contributing staff and organizations involved in this year's SER are listed below.

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The SER Production Team, consisting of those above, would like to thank the staff and management from the following organizations who assisted in the report preparation, provided technical peer review and comments, collected samples and data, prepared maps and diagrams, and provided the analytical services and other support necessary to make this year's report possible:

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*Information Services Division*
*Office of Management Services*
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Results presented in the *SER 2000* are from samples collected, analyzed, and organized by the staff of the Environmental Services Division and the Radiological Control Division. A special word of thanks is extended to those staff, who include:

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Chapter 1

# Introduction

Brookhaven National Laboratory (BNL) hosts thousands of visitors each year, from world renowned scientists conducting research at Brookhaven's unique science facilities, to local school children learning about the mysteries of the universe and our environment. As a U.S. Department of Energy national laboratory located in the center of the unique pine barrens ecosystem of Long Island, New York, BNL is committed to conducting its mission of research and education in a safe and environmentally responsible manner. The Laboratory prepares this Site Environmental Report annually to summarize the status of its environmental programs and performance. This report also describes any impacts both past and present that BNL research operations may have had on the environment. Chapter 1 describes BNL's facilities, ecological resources onsite, and the human populations nearby. It also discusses local site characteristics in terms of geology, hydrology, and climate. This introduction provides background material for the technical information in the chapters that follow.

### 1.1 PURPOSE OF THE SITE ENVIRONMENTAL REPORT 2000

The U.S. Department of Energy (DOE) requires its facilities, including Brookhaven National Laboratory (BNL), to report annually on environmental performance. The *Site Environmental Report* (SER) is prepared in accordance with DOE Order 231.1 (1995) and DOE Order 5400.1 (1988). The SER describes the status and results of BNL's environmental protection programs for calendar year 2000. BNL has been preparing annual SERs since 1968; consequently, the 2000 SER is part of a continuing record of the Laboratory's environmental activities and impacts. The SER also serves a function beyond complying with DOE requirements – it communicates environmental information to BNL staff, DOE, regulators, and the public.

This chapter provides background material to support the technical information in the chapters that follow. Chapter 2 describes BNL's environmental management system and programs, including pollution prevention and environmental restoration. Chapter 3 summarizes BNL's compliance with the wide variety of environmental regulations and permits that govern site operations. Chapters 4 through 7 discuss specific programs and data by environmental media, including air (Chapter 4), surface water (Chapter 5), natural and cultural resources (Chapter 6), and groundwater (Chapter 7). Chapter 8 provides information on radiological dose to individuals and flora and fauna. Finally, Chapter 9 describes how BNL ensures the data used to monitor environmental impact are of high quality and accuracy. The Appendices provide definitions of technical terms, an explanation of the concepts of radioactivity, and more detailed technical and operational data.

A condensed version of the SER is available in a separate Summary Booklet (see inside front cover for ordering information). The Summary Booklet provides information to visitors, students, and members of the public in support of BNL's educational and community outreach program.

### 1.2 BROOKHAVEN NATIONAL LABORATORY OPERATIONS

Brookhaven Science Associates (BSA) operates BNL for the DOE. BSA is a not-for-profit partnership between Battelle Memorial Institute and the Research Foundation of the State University of New York on behalf of the State University of New York at Stony Brook. BSA began operating the Laboratory on March 1, 1998 under DOE Contract No. DE-AC02-98CH10886. From 1947-1998, BNL was operated by Associated Universities Incorporated. Prior to 1947, the site served as a U.S. Army training camp called Camp Upton, which was active from 1917-1920 for World War I and 1940-1946 for World II.

Approximately 3,000 resident scientists and support staff work at BNL. In addition, more than 4,000 academic and industrial researchers from all over the world visit the site each year to participate in scientific collaborations. BNL's annual budget is approximately $424 million with 88% of its funding coming from DOE. The remainder is from other domestic and international scientific and industrial clients. Just a few of the scientific discoveries at BNL include: discovery of new sub-atomic particles, development of medical treatments for Parkinson's disease and cancer, advances in biotechnology for cleaning up pollution, and innovative materials for computer chips.

The majority of the Laboratory's budget directly supports the local economy through wages and purchases of materials and services. In fiscal year 2000, BNL purchased more than $31 million worth of supplies and services from Long Island businesses. Employee salaries, wages, and fringe benefits accounted for 61%, or $258 million, of the Laboratory's total budget. Additionally, most of the Laboratory's 3,000 employees live and shop locally in Suffolk County and throughout Long Island (see Section 1.5). An independent Suffolk County Planning Commission report concluded that BNL's operating, procurement, payroll, construction, medical benefits, and technology transfer spending spreads throughout Long Island's economy, making the Laboratory vital to Long Island's economic health (Kamer 1995).

### 1.3 MISSION OF BROOKHAVEN NATIONAL LABORATORY

BNL's broad mission is to produce excellent science and advanced technology in a safe, environmentally responsible manner with the cooperation, support, and appropriate

involvement of the community. Specifically, the elements of the BNL mission are to

- Conceive, design, construct, and operate complex, leading-edge, user-oriented facilities in a safe and environmentally benign manner that is responsive not only to DOE, but also to the needs of the users.
- Carry out basic and applied research in long-term programs at the frontier of science that supports DOE missions and the needs of the Laboratory's user community.
- Develop advanced technologies that address national needs and initiate their transfer to other organizations and to the commercial sector.
- Disseminate technical knowledge to educate new generations of scientists and engineers, to maintain technical currency in the nation's workforce, and to encourage scientific awareness in the general public.

BNL's early research focused on advanced physics, but rapidly expanded into its current suite of research in the fields of medicine, biology, chemistry, physics, materials science, nuclear engineering, and environmental research. The Laboratory's large and unique scientific user facilities make this research possible, providing the tools for BNL scientists and visiting researchers to extend the boundaries of knowledge and technology.

BNL's policy is to integrate environmental stewardship into all facets of the Laboratory's mission and operations. Figure 1-1 shows BNL's Environmental Stewardship Policy, which represents the highest level of commitment to conducting research and operational activities in a manner that protects the ecosystem and public health.

### 1.4 HISTORY OF RESEARCH FACILITIES AT BROOKHAVEN NATIONAL LABORATORY

BNL was founded in 1947 by the Atomic Energy Commission and operated by AUI on the site of the U.S. Army's former Camp Upton. 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, the Brookhaven Graphite Research Reactor (BGRR), began operations in 1950. The BGRR was a research reactor used for peaceful scientific exploration in the

**ENVIRONMENTAL STEWARDSHIP POLICY**

*It is Brookhaven National Laboratory's (BNL's) policy to integrate environmental stewardship into all facets of the Laboratory's missions. We will manage our programs in a manner that protects the ecosystem and public health.*

*In support of this policy, BNL makes the following commitments:*

♦

*We are committed to achieving compliance with applicable environmental requirements.*

♦

*In consideration of the potential impacts of our activities on the environment, we will integrate pollution prevention/waste minimization, resource conservation, and compliance into all of our planning and decision-making. We will adopt cost-effective practices that eliminate, minimize or mitigate environmental impacts.*

♦

*We will define, prioritize, and aggressively correct and clean up existing environmental problems.*

♦

*We will work to continually improve our environmental management system and performance. We will establish appropriate environmental objectives and performance indicators to guide these efforts and measure our progress.*

♦

*We will maintain a positive, proactive, and constructive relationship with our neighbors in the community, regulators, DOE, and our other stakeholders. We will openly communicate with stakeholders on our progress and performance.*

*In addition to my annual review of BNL's progress on environmental goals and adherence to this policy, I invite all interested parties to provide me with input on our performance relative to this policy, and the policy itself.*

John H. Marburger

John H. Marburger, Laboratory Director

*11/19/98*

Date

**Figure 1-1. Environmental Stewardship Policy.**

fields of medicine, biology, chemistry, physics, and nuclear engineering. The BGRR operated until 1969 and is now being decommissioned. Its capacity was replaced and surpassed in 1965 by the High Flux Beam Reactor (HFBR), which provided neutrons to researchers of all disciplines, from solid state physics to art history. During a scheduled maintenance shutdown in 1997, a leak in the HFBR's spent fuel storage pool was discovered. In November 1999, the Secretary of Energy made a decision to permanently close the HFBR.

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. Chemists and physicians could view the inner workings of the brain in 1977 with the advent of Positron Emission Tomography (PET) cameras. Two more imaging techniques were added to the PET research efforts to form the Center for Imaging and Neuroscience in 1996. Except for the BMRR, all of these facilities are currently operating. Due to a reduction of research funding, the BMRR conducted its last run on December 28, 2000, and transition and stabilization activities will begin in 2001.

High-energy particle physics research at BNL began in 1952 with the Cosmotron, the first particle physics accelerator to achieve billion-electron-volt energies. Work at the Cosmotron resulted in a Nobel Prize-winning discovery in physics in 1957. In 1960, the Alternating Gradient Synchrotron (AGS), a much larger accelerator that surpassed the Cosmotron's capabilities, became operational. It has yielded many discoveries on new particles and phenomena, for which BNL researchers were awarded three more Nobel Prizes in physics in 1976, 1980, and 1988. The AGS continues to operate. Another accelerator, the Tandem Van de Graaff, began operating in 1970 and continues operating to the present. In 1982, the National Synchrotron Light Source (NSLS) began operation. The NSLS guides charged particles in an orbit. As the electrons spin inside a hollow donut-shaped tube called an electron storage ring, they give off light called synchrotron light. This light, which can be detected by specialized instruments, has many uses in both the physical and biological research sciences.

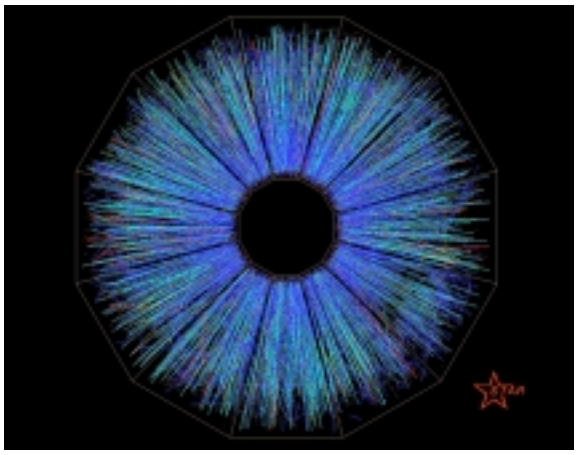


**Figure 1-2. End View of a Gold-Ion Collision at the RHIC Facility.**

Brookhaven's newest accelerator facility, the Relativistic Heavy Ion Collider (RHIC) began operation in 2000. RHIC is designed to recreate a state of matter that scientists believe existed moments after the universe was formed (Figure 1-2). The RHIC is an example of Brookhaven's commitment to fully integrate today's world-class science with world-class protection of the environment; in August 1999, the RHIC became the first facility at BNL and the first on Long Island to receive International Organization for Standardization ISO 14001 Environmental Management System certification (see Chapter 2 for details). In 2000, eight additional facilities at BNL also received ISO 14001 certification and the entire Laboratory is scheduled to become ISO 14001 registered in 2001. BNL will be the first national laboratory to receive this registration.

Unfortunately, historical operations and waste management practices at BNL led to releases of chemicals and radioactive materials that resulted in soil and groundwater contamination. In 1989, BNL was added to the federal Comprehensive Environmental Response, Compensation & Liability Act National Priorities List of environmentally contaminated sites nationwide identified for priority cleanup. In the past three years, BNL has made significant progress towards improving environmental operations and remediation of past contamination (see Chapter 2 for details). In 2000, BNL received an "Outstanding" performance rating from DOE for its environmental, health and safety performance, the highest ranking for the site in three years.

**Figure 1-3. Landsat 7 Satellite Image of Long Island** *(Image courtesy of NASA).*

### 1.5 SITE LOCATION AND LOCAL POPULATION

BNL is located near the geographical center of Suffolk County, Long Island, New York. BNL is in Brookhaven Township, about 60 miles east of New York City (Figure 1-3). About a third of the 1.39 million people that reside in Suffolk County live in Brookhaven Township (LIPA 2000). Figure 1-4 shows the distribution of the resident population on parts of Long Island. As with all townships on Long Island, there has been an increase in residential housing in Brookhaven Township in recent years, a trend that is expected to continue.

Approximately 250-300 people reside long-term in the apartments and cottages onsite, while many of the 4,000 visiting scientists each year stay short term in the onsite guesthouses. Figure 1-5 shows the housing capacity for onsite residents and visitors. In addition to onsite staff and visiting scientists, more than 35,000 visitors participated in educational and public outreach activities conducted onsite during 2000. Finally, more than 75% of BNL's 3,000 employees live within a 15-mile radius of the Laboratory (Figure 1-6).

### 1.6 FACILITY AND OPERATIONS DESCRIPTION

Most of BNL's principal facilities are located near the center of the 5,265 acre (8.23 square mile) site. The developed area is approximately 1,650 acres, consisting of about

- 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 occupied by 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 largely wooded and represents native pine barren ecology. In November 2000 DOE and the U.S. Fish and Wildlife Service set aside 530 acres of the undeveloped land at BNL as the Upton Ecological and Research Reserve (see Figure 1-7). More information about natural resources onsite, the Reserve and the plants and animals it protects can be found in Section 1.9 and in Chapter 6.

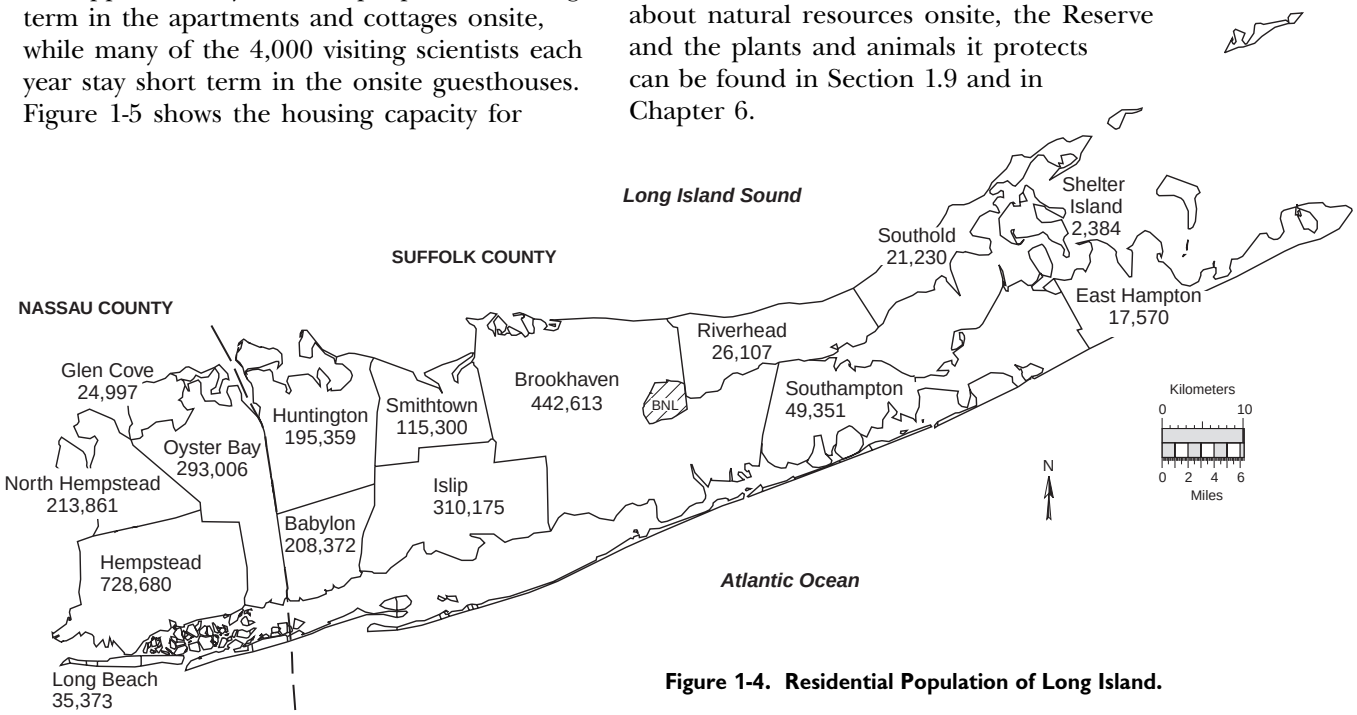
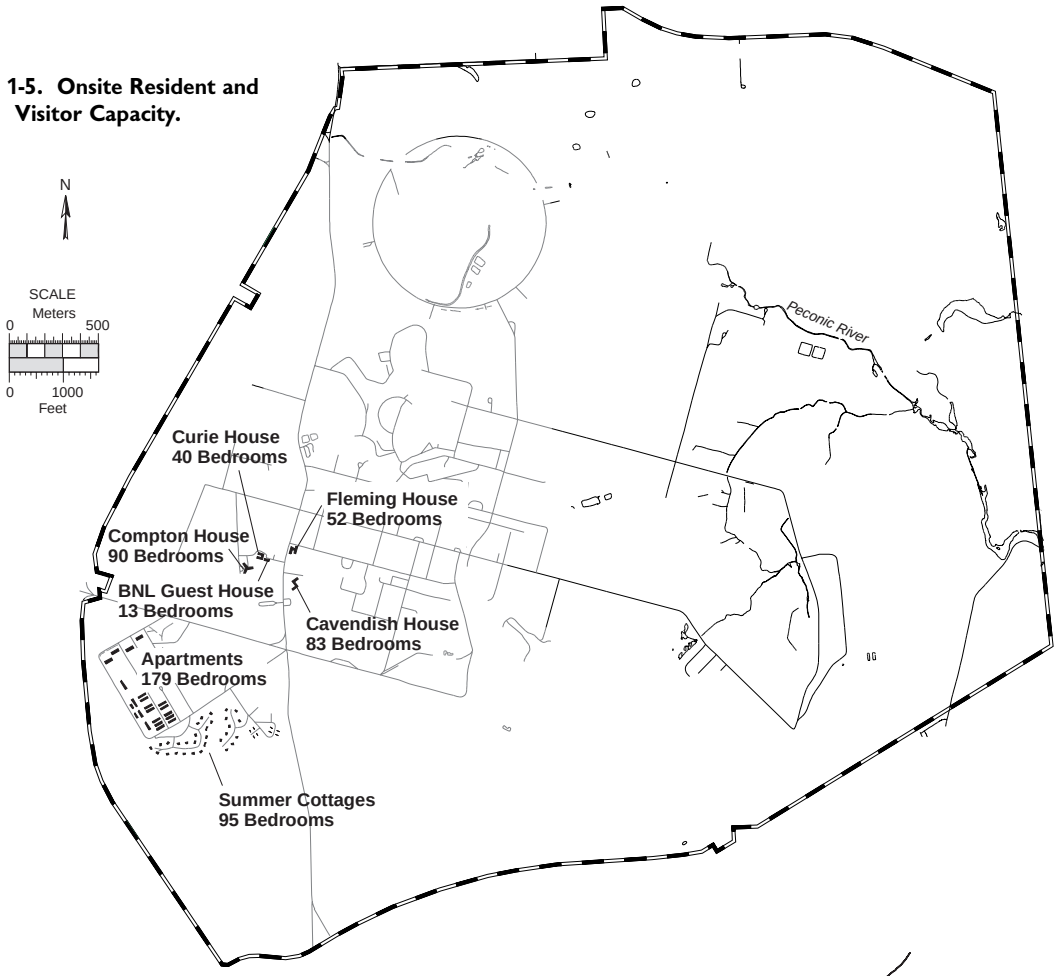



**Figure 1-4. Residential Population of Long Island.**

**Figure 1-5. Onsite Resident and Visitor Capacity.**



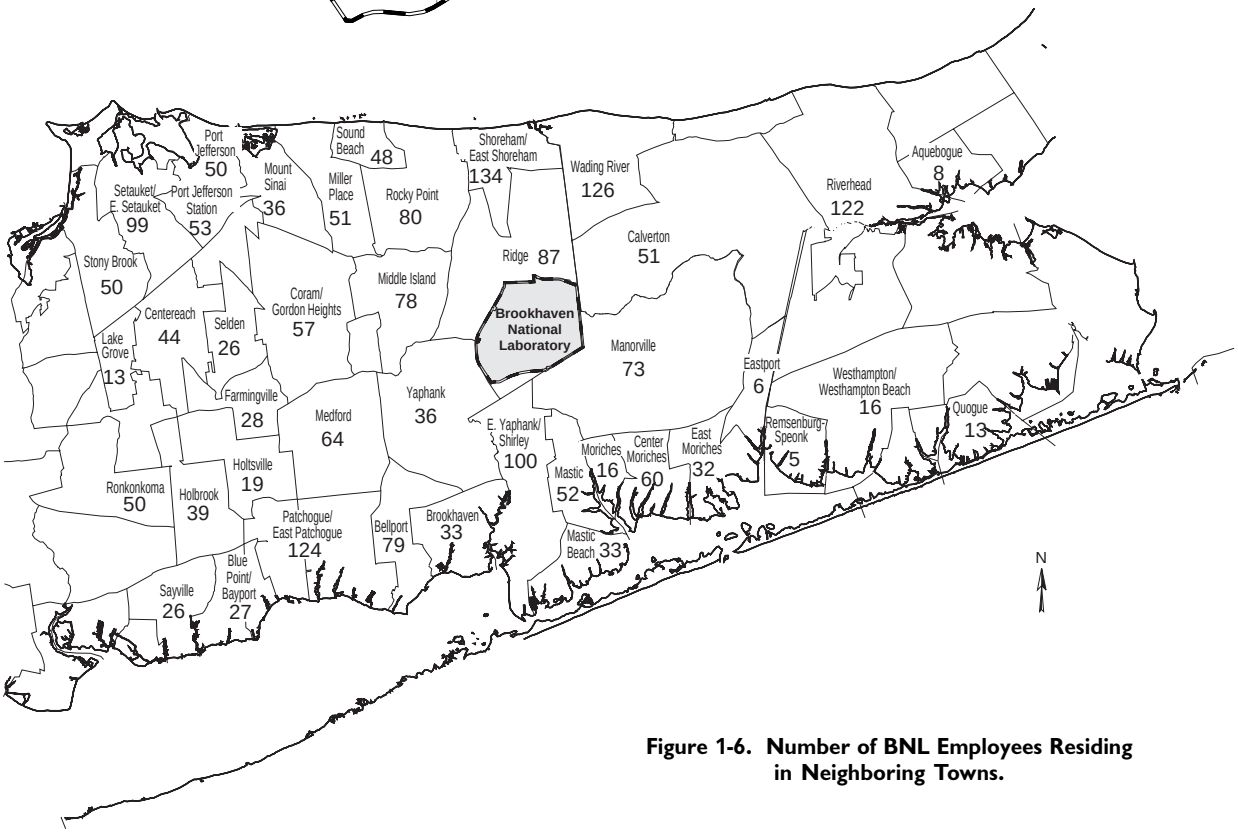




**Figure 1-6. Number of BNL Employees Residing in Neighboring Towns.**

**Figure 1-7. Dedication of the Upton Ecological and Research Reserve.** *(From left to right)* BNL Natural Resource Manager, Dr. Timothy Green; U.S. Senator Charles Schumer; and former U.S. DOE Secretary of Energy Bill Richardson help dedicate the reserve.

The major scientific facilities at BNL are shown and briefly described in Figure 1-8. As noted earlier, the three research reactors, the BGRR, the HFBR, and the BMRR, are no longer operational.

In addition to the scientific facilities, numerous other facilities support BNL's science and technology mission by providing basic utility and environmental services (see Figure 1-9):

- *Water Treatment Plant.* The Water Treatment Plant is a potable water treatment facility with a capacity of 5 million gallons per day (actual 2000 usage averaged 2.8 million gallons per day, see Chapter 2 for more information). Potable water is obtained from six wells located along the western boundary of the developed site and 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 are at or below New York State drinking water standards.
- *Central Chilled Water Plant.* This facility provides chilled water for air conditioning and process refrigeration for the entire site via a network of underground piping. The plant has a large refrigeration capacity with once-through cooling, reducing the need for local refrigeration plants.
- *Central Steam Facility.* The Central Steam Facility is a dual fuel-fired plant that provides high-pressure steam for both facility and process heating for the entire site. Natural gas is the primary fuel and fuel oil is the secondary fuel. Steam is conveyed to the user facilities through a network of underground piping. Condensate is collected and returned to the facility for reuse to conserve water and energy.
- *Major Petroleum Facility.* The Major Petroleum Facility provides reserve fuel for the Central Steam Facility during times of peak operation. This facility has a total capacity of 1.8 million gallons (6.8 million liters) for storing predominately No. 6 fuel oil. The 1997 conversion of the boilers at the Central Steam Facility to natural gas has significantly reduced BNL's reliance on oil as a source of fuel.
- *Sewage Treatment Plant.* The Sewage Treatment Plant receives sanitary and certain process wastewater from BNL facilities for treatment prior to discharge into the Peconic River, similar to the operations of a municipal sewage treatment plant. The Sewage Treatment Plant has a design capacity of 3 million gallons (11 million liters) per day. The effluent is monitored and controlled under a permit issued by the New York State Department of Environmental Conservation. See Chapter 3 for additional information on this facility and associated environmental permits.
- *Waste Management Facility.* The Waste Management Facility is a state-of-the-art complex for managing the wastes generated from BNL's research and operations activities. This facility, which opened in December 1997, was built with advanced environmental protection systems and features. The Waste Management Facility houses two areas permitted by the New York State Department of Environmental Conservation for storing hazardous wastes, prior to shipment offsite for treatment and disposal at other permitted treatment, storage, and disposal facilities. See Chapter 2 for more information on waste management.
- *Fire Station.* The BNL Fire Department provides fire prevention and response onsite as well as hazardous materials and medical response. They maintain five response vehicles at the Fire Station and typically respond within 8 minutes to any onsite emergency.

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**Figure 1-8. Major Brookhaven Scientific Facilities.**

**1. RELATIVISTIC HEAVY ION COLLIDER (RHIC)**

RHIC is one of the world's largest and most powerful accelerators. RHIC's main physics mission is to study particles smaller than atoms.

**2. ALTERNATING GRADIENT SYNCHROTRON (AGS)**

The AGS is used for high-energy physics research and accelerates protons to energies up to 30 GeV, and heavy-ion beams to 15 GeV. A 200 MeV Linear Accelerator, described below, serves as a proton injector for the AGS and also supplies a continuous beam of protons for radionuclide production by spallation reactions in the Brookhaven Linac Isotope Producer facility.

**3. AGS BOOSTER**

The AGS Booster is a circular accelerator, 200 meters in circumference, that receives either a proton beam from the LINAC, or heavy ions from the Tandem Van de Graaff. The Booster accelerates proton particles and heavy ions before injecting them into the AGS ring. This facility became operational in 1992.

**4. LINEAR ACCELERATOR (LINAC) AND BROOKHAVEN LINAC ISOTOPE PRODUCER (BLIP)**

The LINAC provides beams of polarized protons for the AGS and for the Relativistic Heavy Ion Collider. BLIP utilizes the excess beam capacity of the LINAC to produce radioisotopes used in research and medical imaging. It is one of the key production facilities in the nation for radioisotopes which are crucial to clinical nuclear medicine. It also supports research BNL on new diagnostic and therapeutic radiopharmaceuticals.

**5. HEAVY ION TRANSFER LINE (HITL)**

The HITL connects the Tandem Van de Graaff and the AGS. This interconnection permits ions of intermediate mass to be injected into the AGS where they can be accelerated to an energy of 15 GeV/amu. These ions then are 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 for radiation therapy of 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 applications. It produced neutrons in an optimal energy range for experimental treatment of a type of brain cancer known as glioblastoma multiforme. This reactor stopped operating in December 2000.

**8. SCANNING TRANSMISSION ELECTRON MICROSCOPE (STEM)**

This 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.

**9. NATIONAL SYNCHROTRON LIGHT SOURCE (NSLS)**

The NSLS utilizes a linear accelerator and booster synchrotron as an injection system for two electron storage rings which operate at energies of 750 MeV vacuum ultraviolet (VUV), and 2.5 GeV (x-ray). The synchrotron radiation produced by the stored electrons is used for VUV spectroscopy and x-ray diffraction studies.

**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 as well as expanded the knowledge base of physics, chemistry and biology. A leak in the fuel storage pool was discovered in 1997. Since that time the HFBR has not been in operation and was permanently shut down in November 1999.

**11. TANDEM VAN DE GRAAFF AND CYCLOTRON**

These two facilities are used in medium-energy physics investigations, and for producing special nuclides. The heavy ions from the Tandem Van de Graaff also can be injected into the AGS for physics experiments.

**12. BROOKHAVEN GRAPHITE RESEARCH REACTOR (BGRR)**

No longer in operation, the BGRR was used for scientific exploration in the field of medicine, biology, chemistry, physics, and nuclear engineering.

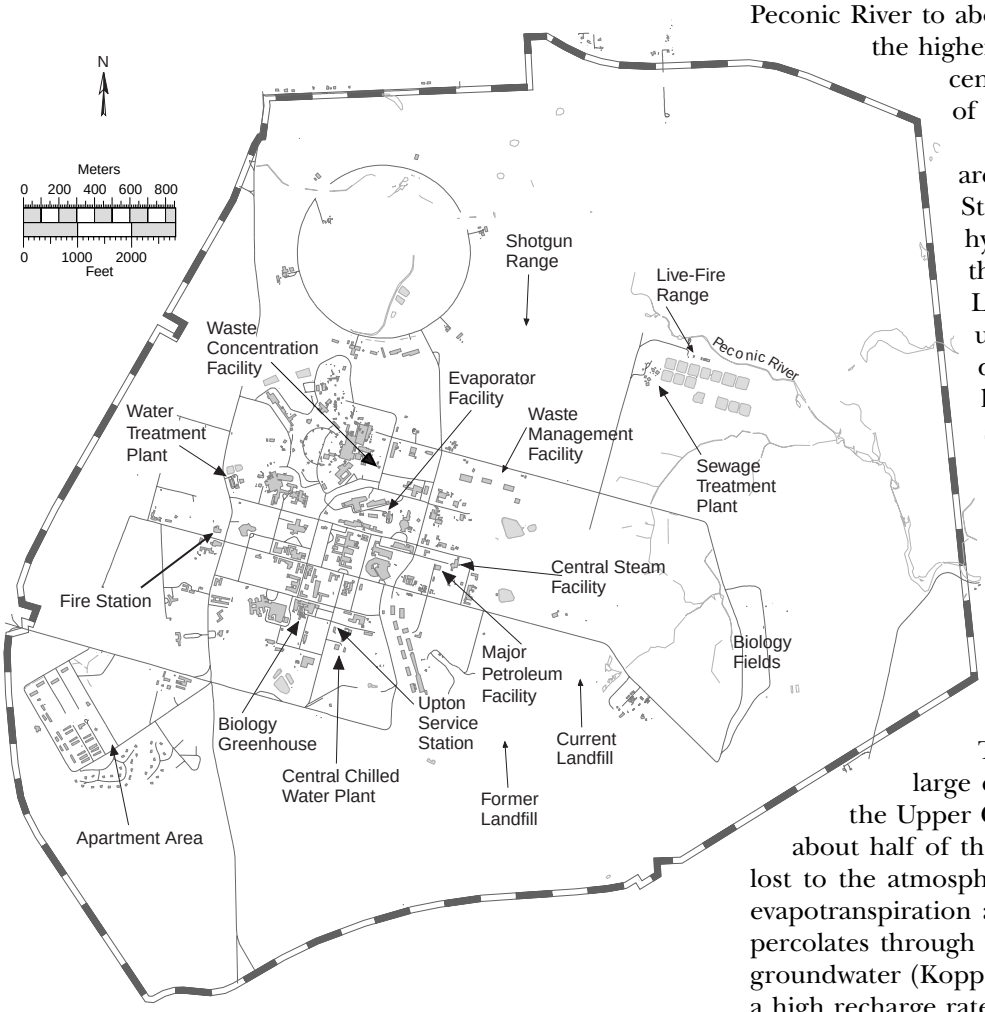



**Figure 1-9. Major Brookhaven Support and Services Facilities.**

### 1.7 GEOLOGY AND HYDROLOGY

BNL lies 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. The Peconic River both recharges to, and receives water from, the sole source aquifer system underneath Long Island, depending on the position of the water table relative to the base of the riverbed. In times of sustained drought, the river water typically recharges to groundwater; with normal to above-normal precipitation, the river receives water from the aquifer. In general, the terrain of the site is gently rolling, with elevations varying between 44 and 120 feet (13 and 37 meters) above sea level. Depth to groundwater from the surface of the land ranges from 5 feet (1.5 meters) near the Peconic River to about 80 feet (24 meters) in the higher elevation areas in the central and western portions of the site.

The hydrology of this area is very 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 (37 and 76 meters) 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 called 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 area has a high recharge rate (22 inches [56 centimeters] per year) that varies seasonally.

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, SCDHS 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. It is estimated that up to two-fifths of the recharge from rainfall moves into the deeper aquifers. The extent to which groundwater at the BNL 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 onsite and offsite private and public supply wells and, as such, has been designated a sole source

aquifer system by the U.S. Environmental Protection Agency. BNL uses approximately 2.8 million gallons (10.6 million liters) per day of groundwater to meet site potable water needs and heating and cooling requirements. Approximately 74% of the water pumped from BNL supply wells is returned to the aquifer through onsite recharge basins. About 19% is discharged into the Peconic River. Human consumption, evaporation (cooling tower and wind losses), and sewer line losses account for the remaining 7%. An additional 0.6 million gallons (2.3 million liters) per day of groundwater is pumped from remediation wells for treatment and then returned to the aquifer by the use of recharge basins.

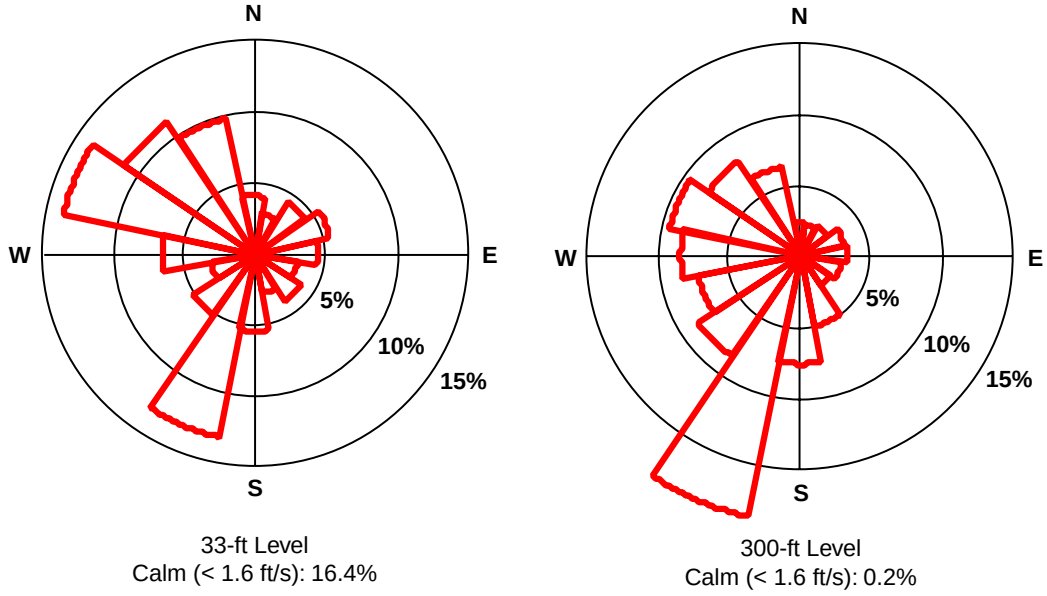
Groundwater flow direction across the BNL site is influenced by natural drainage systems moving eastward along the Peconic River, southeast toward the Forge River and south toward the Carmans River. Pumping from onsite water supply wells also impacts the direction and speed of groundwater flow, especially in the central, developed areas of the site. Two natural groundwater divides have been identified near the BNL site (Scorca *et al.* 1999). One is located approximately one-half mile north of BNL and a second transects portions of the site when the water table is high and the aquifer flows into the stream bed of the Peconic River. These divides define the boundaries of the area contributing groundwater to the Peconic River watershed.

In most areas at BNL, the horizontal velocity of groundwater is approximately 0.75-1.2 feet per day (0.23-0.37 meters per day) (Geraghty and Miller 1996). In general terms, this means that it takes approximately 20 to 22 years for groundwater to travel from the central developed area of the site to the BNL southern boundary.

Chapter 7 provides details on BNL's comprehensive Groundwater Protection Management Program.

### 1.8 CLIMATIC DATA

The Meteorological Group at Brookhaven National Laboratory has collected meteorological data onsite since 1949. The prevailing ground level winds at BNL are from the southwest during the summer, from the northwest during the winter, and about equal from these two directions during the spring and fall (Nagle 1975, Nagle 1978). Figure 1-10 shows the 2000 annual wind rose




Explanation: The arrows formed by the wedges indicate wind direction. Each concentric circle represents a 5% frequency, that is, how often the wind is coming from that direction. The wind direction was measured at heights of 33 and 300 feet (10 and 90 meters). For example, this diagram indicates that the predominant wind direction at 300 feet (90 meters) was from the south-southwest.

**Figure 1-10. Annual Wind Rose for 2000.**

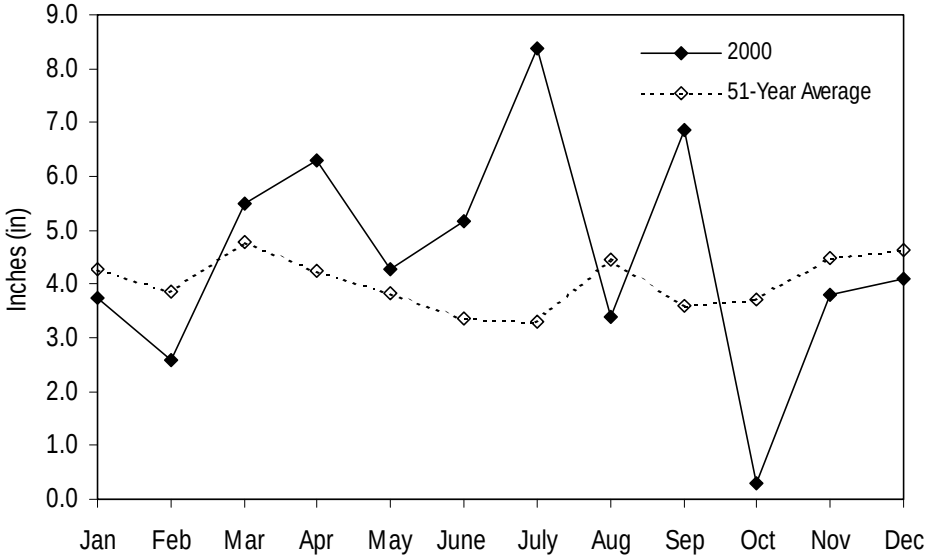



**Figure 1-11. 2000 Monthly Precipitation Versus 51-Year Monthly Average.**

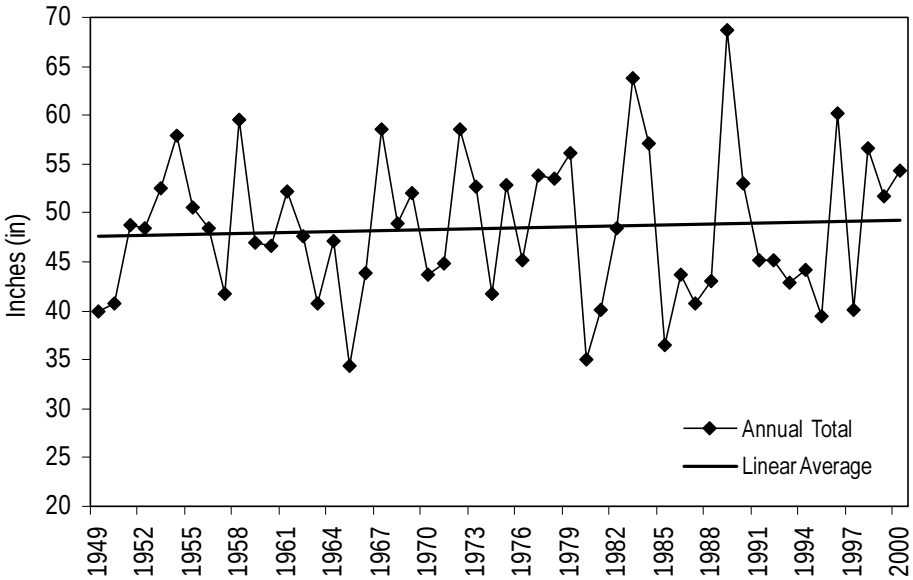



**Figure 1-12. Fifty-One Year Annual Precipitation Trend (1949-2000).**

for BNL, which depicts the annual frequency distribution of wind speed and direction, measured at an onsite meteorological tower at heights of 33 and 300 feet (10 and 90 meters).

The total precipitation for 2000 was 54.37 inches (138.10 centimeters). Most of the precipitation occurred from March through September, with the late fall and winter months drier than average. With 8.37 inches (21.26 centimeters) of rain, July of 2000 was the second wettest July since BNL started keeping meteorological records in 1949 (the wettest July occurred in 1969). From July 25 through August 19, 2000, only five days were rain-free. In contrast, there were only 0.31 inches (0.79 centimeters) of rain in October. Overall, the year 2000 was wetter than average; the precipitation was 5.89 inches (14.96 centimeters) above the 51-year annual average. Figures 1-11 and 1-12 present the 2000 monthly and the 51-year annual precipitation data, respectively.

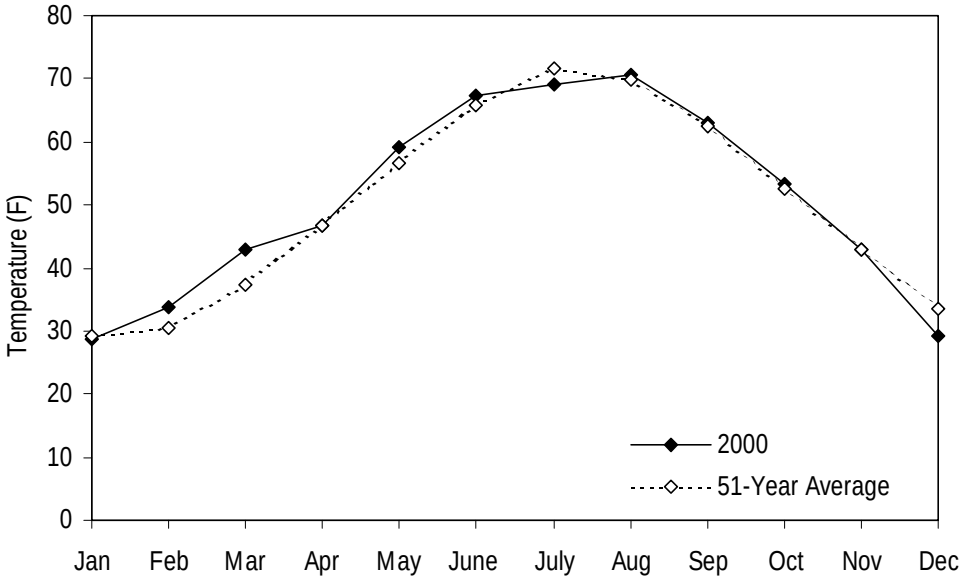



**Figure 1-13. 2000 Monthly Mean Temperature Versus 51-Year Monthly Average.**

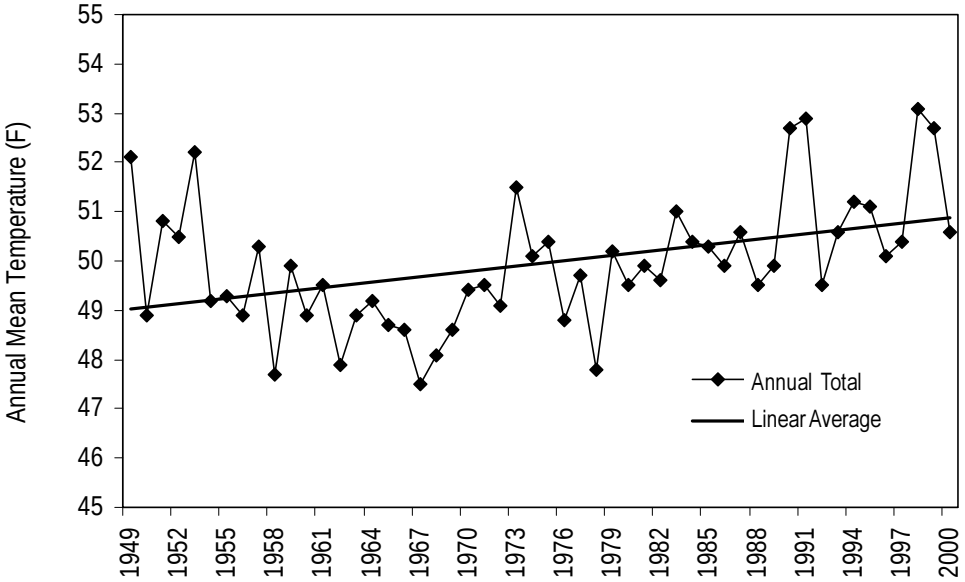



**Figure 1-14. Fifty-One Year Annual Mean Temperature Trend (1949-2000).**

The monthly mean temperature in 2000 was 50.6°F (10.3°C), ranging from a monthly mean low temperature of 28.7° F (–1.8°C) in January to a monthly mean high temperature of 70.5°F (21.4°C) in August. The year 2000 was slightly warmer than average at 0.6°F (0.3°C) above the 51-year annual average of 50.0°F (10.0°C). In general, using a linear average, temperatures at BNL have increased 1.83°F (1.01°C) over the last 51 years, compared to a worldwide average surface temperature increase of 0.5°F (0.3°C) over approximately the same time period (Jones *et al.* 1999). Five record daily high temperatures were recorded in 2000 on January 2 and 3, March 9 and 24, and October 3. The most notable of these was a record high of 66°F (19°C) on January 3, 2000, beating the previous record of 53°F (12°C) set in 1953. Figures 1-13 and 1-14 show the 2000 temperatures and the historical annual mean temperatures, respectively.

### 1.9 ECOLOGICAL RESOURCES

BNL is located in the oak/chestnut forest region of the Coastal Plain. BNL property constitutes about 5% of the 100,000-acre New York State designated region known as the Central Pine Barrens. Additionally, part of the Peconic River running through BNL's property was designated "scenic" by the New York State Wild, Scenic, and Recreational River System Act (New York State 1972). As noted before, because of the general topography and porous soil, the land is very well drained and generally there is 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 onsite. Thus, a mosaic of wet and dry areas on the site correlates with variations in topography and depth to the water table. Vegetation onsite is in various stages of succession, which reflects a history of disturbances to the area. For example, during the construction of Camp Upton in 1917, the site was entirely cleared of its native pines and oaks; the site was 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.

Over 230 plant species have been identified onsite. The 15 mammal species onsite include species common to mixed hardwood forests and open grassland habitats. The white-tailed deer density is currently estimated at 236 per square mile, compared to the 85 per square mile estimated in 1992 (Thomlinson 1993). At least 85 species of birds are known to nest at BNL, and an additional 130 species have been documented as "visiting" the site. These numbers are a result of BNL's location within the Atlantic Flyway and the scrub/shrub habitats that offer food and rest to migratory songbirds. Open fields bordered by hardwood forests at the recreation complex are excellent hunting areas for hawks. Permanently flooded retention basins and other watercourses support amphibians and aquatic reptiles. Nine amphibian and 10 reptile species have been identified, as well as 9 species of fish.

Ecological studies at the BNL site have confirmed fifteen breeding sites for the New York State endangered eastern tiger salamander (*Ambystoma t. tigrinum*) in vernal pools and some recharge basins. The New York State Department of Environmental Conservation listed the banded sunfish (*Eanneacanthus obesus*) as a state threatened species in 1999. It lives solely within the Peconic River system, including backwater areas of the river onsite (Scheibel 1990). In 2000, the New York State-threatened swamp darter (*Etheostoma fusiforme*) was positively identified onsite in one of the larger ponds associated with the Peconic River. One New York State-threatened plant is found onsite: the stiff goldenrod (*Solidago rigida*). A discussion of the Laboratory's wildlife protection strategy can be found in Chapter 6.

In November 2000 DOE joined with the U.S. Fish and Wildlife Service to establish the Upton Ecological and Research Reserve. At 530 acres, the Upton Ecological and Research Reserve sets aside 10% of BNL property for conservation and ecological research. The Reserve will permanently preserve a portion of the Central Pine Barrens, a unique ecosystem of forests and wetlands on Long Island. This area provides habitat for approximately 27 endangered, threatened, or species of special concern, including the state endangered eastern tiger salamander and the state-threatened banded sunfish and swamp darter. Other wildlife species of interest that inhabit this area include the wild turkey, red fox, eastern box turtle, and the red-tailed hawk. DOE has committed to providing the U.S. Fish and Wildlife Service with $200,000 a year, over a five-year period, for land management activities and research in the Upton Ecological and Research Reserve. More information about the Reserve and the plants and animals it protects can be found in Chapter 6.

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Chapter 2

# Environmental Management System

In 2000, BNL continued to implement and enhance its Environmental Management System to ensure that it operates in an environmentally responsible manner. The Laboratory's Environmental Management System conforms to the international standard on environmental management known as ISO 14001, with increased emphasis on compliance assurance, pollution prevention, and community outreach. Nine BNL organizations have been officially registered to the ISO 14001 Standard, affirming the Laboratory's leadership position as the first Long Island-based operation and the first DOE Office of Science facility to achieve this accreditation.

Under the Environmental Management System, compliance and other environmental considerations are fully integrated into the planning, decision-making, and implementation phases of all site activities. Existing industrial and experimental processes onsite have been evaluated for regulatory compliance and pollution prevention opportunities, and actions are being taken to improve BNL's compliance status and eliminate potential sources of environmental impact. In 2000, pollution prevention projects saved more than $2,265,512 and resulted in the reduction or reuse of over 3,367,593 pounds (1.53 million kilograms) of industrial, sanitary, radioactive, and hazardous waste, and 63,500,000 gallons (240 million liters) of water.

The Laboratory continues to address historical issues under the Facility Review Project and the Environmental Restoration Program. A comprehensive program to monitor environmental quality is in place. The Laboratory is openly communicating with neighbors, regulators, employees, and other interested parties on environmental issues and progress.

## 2.1 ENVIRONMENTAL STEWARDSHIP UNDER BROOKHAVEN SCIENCE ASSOCIATES

During 2000, BNL continued to implement and improve its Environmental Management System (EMS) under the leadership of Brookhaven Science Associates, LLC (BSA). An EMS is a methodology for managing the environmental aspects of an organization's operation in order to

- identify how operations can potentially impact the environment,
- define and prioritize what needs protection and how to do it,
- monitor, measure, and communicate what is done and how it is done, and
- continually improve environmental protection programs.

An EMS includes planning; establishing responsibilities; instituting procedures, practices, and processes; and dedicating resources to develop, implement, and achieve environmental commitments. The purpose of an EMS is to ensure that programs are managed in an environmentally responsible manner that protects the ecosystem and human health. The ultimate goal is to improve environmental performance and environmental quality.

BNL's EMS uses the International Organization for Standardization ISO 14001 Standard, *Environmental Management Systems - Specification with Guidance for Use* (ISO 1996) as a model. ISO 14001 is a consensus standard developed by an international consortium of industry, government, and environmental groups. This system has been adopted by not-for-profit organizations such as BNL, as well as by the private sector at companies such as Lucent Technologies, IBM, and Motorola. BNL refers to its EMS as an ISO 14001 "Plus" system, since it has enhanced emphasis on compliance, pollution prevention, and community outreach. The EMS is integrated with the Laboratory's other management systems such as training and emergency preparedness, and is part of the sitewide Integrated Safety Management System.

BNL has invested more than $2,000,000 in a three-year project to develop and implement the EMS. The project is fundamentally and systematically changing the way the Laboratory operates. Under the project, existing EMS elements and other management systems were identified, revamped or enhanced, and integrated with each other. An ISO 14001 EMS consists of 17 major elements. Figure 2-1 shows the relationship between the program elements. Table 2-1 summarizes how BNL is satisfying each element. The following sections describe some of the key components of BNL's EMS in more detail. Sections 2.2 and 2.3 describe major environmental programs that are part of the EMS.

### 2.1.1 SIGNIFICANT ENVIRONMENTAL ASPECTS

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 impacts are significant. Environmental management programs are used to control and manage those aspects to prevent the impacts. Table 2-2 provides a list of BNL's significant environmental aspects. BNL's criteria for significance is based on both actual and perceived impacts of its operations and regulatory requirements. For example, because the Laboratory is situated over a sole source aquifer that provides drinking water, protection of groundwater is a high priority and possible impact to it is a significant concern. Because of concerns on the part of the surrounding community, radioactivity in any environmental media (air, water, soil) is also deemed a significant aspect. As the EMS matures, impacts will be reevaluated as necessary to ensure that the significant aspects and potential impacts continue to reflect the concerns of stakeholders and changes in regulatory requirements, and to incorporate new aspects or impacts that have been identified.

### 2.1.2 EMS PROJECT AND REGISTRATION STATUS

Shortly after BSA assumed management of BNL in March 1998, DOE entered into a voluntary Memorandum of Agreement (MOA) with EPA to address concerns about BNL's environmental programs (EPA/DOE 1998). A copy of the MOA is available on the BNL website at <http://www.doe.bnl.gov/epa/EPA1.htm>. Among other things, the MOA committed DOE to implementing an ISO 14001 "Plus" EMS on a very aggressive schedule. At that time, the initiative lacked a project manager with clear roles and responsibilities, personnel resources had not been completely identified, funding was not authorized, and there was general lack of ownership for environment, health, and safety areas by line management.

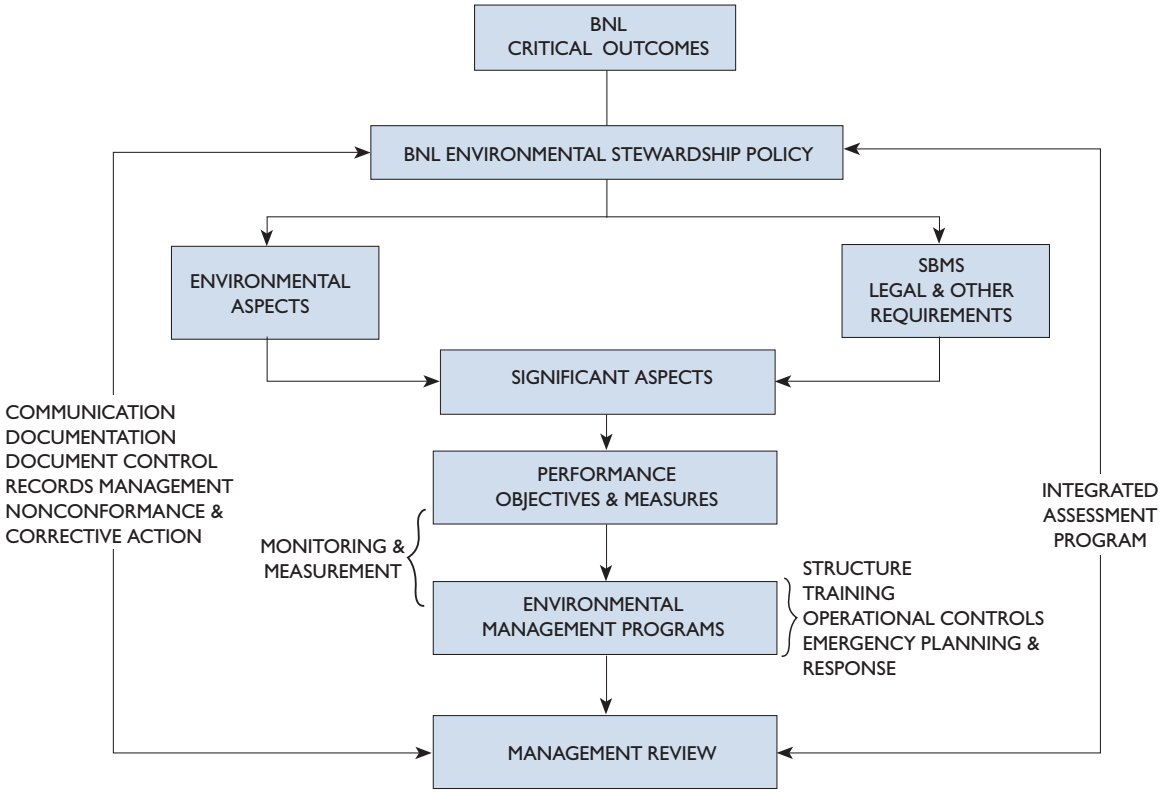


**Figure 2-1. Key Elements of the BNL EMS and Their Relationship to Each Other.**

The EMS project began on June 1, 1998. Even before the MOA was signed, BSA had decided to go beyond what the DOE operating contract required, electing to ultimately register the entire Laboratory to the ISO 14001 Standard, as opposed to self-declaring that they had a conforming system. The registration process involves rigorous audits by an American National Standards Institute Registrar Accreditation Board. The independent auditors evaluate BNL's conformance to the standard, whether the program is effectively implemented, and whether an effective assessment and corrective action program is in place. While the significance of ISO 14001 registration may not be as meaningful to the general public as it is to the environmental and regulatory community, BSA believes that it is important from a trust and credibility standpoint to undergo the third party review. The ISO 14001 EMS is a valuable blueprint, and registration is a recognized mechanism that the outside world can judge.

BNL has pursued a phased approach, registering high profile facilities first. The project started with a pilot phase involving the Relativistic Heavy Ion Collider (RHIC) Project, the Reactor Division, and the Waste Management Division. During the first two years of the EMS project, BNL developed institutional requirements (see Section 2.1.5) and implemented these program requirements throughout all organizations in the Laboratory. Deployment of the EMS in the balance of facilities began in July 1999 and was completed ahead of schedule in July 2000. An official ISO 14001 registration audit resulted in the August 1999 registration of the RHIC Project. In September 2000, the following eight facilities also obtained registration: the Biology Department, Medical Department, Brookhaven LINAC Isotope Producer and Target Processing Laboratory, Collider-Accelerator Department, Superconducting Magnet Division, Reactor Division, Environmental Restoration Division, and the Waste Management Division. A copy of BNL's registration certificate for these facilities is found in Figure 2-2.

After undergoing an independent, internal audit of conformance at the remaining facilities, all BNL organizational units self-declared

**Table 2-1. Elements of the Environmental Management System: Implementation of ISO 14001 "Plus" at BNL.**

| | |
|---|---|
| **Environmental Policy** | The Environmental Stewardship Policy is a statement of BNL's intentions and principles regarding overall environmental performance. It provides a framework for planning and action. In the policy, BNL has reaffirmed its commitments to compliance, pollution prevention, cleanup, community outreach, and continual improvement. |
| **Environmental Aspects** | When operations have an environmental aspect, BNL implements the EMS to minimize or eliminate any potential impact. BNL has determined that the following aspects of its operations have the potential to affect the environment:<br>• Waste generation<br>• Atmospheric emissions<br>• Liquid effluents<br>• Storage or use of chemicals and radioactive materials<br>• Natural resource usage - power and water consumption<br>• Historical/cultural resources<br>• Environmental noise<br>• Disturbances to endangered species/protected habitats<br>• Soil activation<br>• Historical contamination<br>• Other facility-specific compliance aspects |
| **Legal and other Requirements** | New or revised requirements (e.g. new regulations) are analyzed to determine their applicability to the Laboratory, and to identify whether actions are required to achieve compliance. This may involve developing or revising Laboratory documents or operating procedures, implementing administrative controls, providing training, installing engineered controls, or increasing monitoring. |
| **Objectives and Targets** | BNL establishes environmental objectives and performance measures to drive improvements to the EMS and ultimately, environmental performance. They focus on the environmental aspects that can have a significant impact, address stakeholder concerns, and align with commitments made in the environmental policy. Objectives and targets are developed by Fiscal Year (October 1 through September 30). In Fiscal Year 2000 they included:<br>• Achieve excellent performance in environmental protection (e.g., minimize permit exceedances, spills, and tritium releases).<br>• Complete key environmental improvement projects in a timely manner (e.g., Process Evaluation, EMS, Groundwater, Environmental Restoration).<br>• Minimize waste generation and eliminate legacy wastes.<br>• Enhance the responsiveness and effectiveness of Laboratory communications.<br>Individual organizations augment these Labwide goals with specific goals applicable to their programs. |
| **Environmental Management Program *and Pollution Prevention**** | Organizations within BNL develop action plans detailing how they will achieve their objectives and targets and commit the necessary resources to successfully implement both Labwide 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. |
| **Structure and Responsibility** | 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 their environmental responsibilities. The Deputy Director for Operations manages the ESH&Q Directorate and leads environmental protection efforts. He is responsible for coordinating the implementation of the EMS within BNL and reporting on performance to senior management, and utilizes the staff of the Environmental Services Division to accomplish this task. |
| **Training, Awareness, and Competence** | BNL developed a comprehensive environmental training program in 1999, and in 2000 completed the training of staff, visitors, and contractors to ensure they are competent to carry out their environmental responsibilities. This training program includes general environmental awareness for all employees, regulatory compliance training for select staff, and specific courses for managers, internal assessors, EMS implementation teams, and operations personnel whose work can impact the environment. |
| **Communication *and Community Outreach**** | 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, primarily through the Citizens Advisory Committee and/or the Brookhaven Executive Roundtable. The Commitment Control Tracking System is used to track and ensure response to communication from external interested parties. |

*(continued on next page)*

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

| | |
|---|---|
| **EMS Documentation** | BNL has a comprehensive, up-to-date set of Laboratory-wide environmental documents describing its EMS program. A web-based system called the Standards Based Management System (SBMS) provides access to regulatory requirements, Laboratory-wide procedures, and manuals that tell staff how to control processes and perform work at BNL in a way that protects the environment. SBMS has improved the quality, usability, and communication of Laboratory-level requirements. |
| **Document Control** | SBMS contains a comprehensive document control system to ensure effective management of procedures and other system documents. When facilities require additional procedures to control their work, document control protocols are implemented to ensure that workers have access to the current versions of procedures. |
| **Operational Control** | Through the Process Evaluation Project, work planning and control, experimental design review and EMS implementation, operations at the Laboratory are evaluated for adequacy of current controls to prevent impacts to the environment. As needed, additional administrative or engineered controls are identified and plans for upgrades and improvements are developed and implemented. Key operational control procedures are documented either in SBMS or in facility-specific internal Standard Operating Procedures/work instructions. |
| **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. Results are reported to regulatory agencies and summarized annually in this Site Environmental Report. In addition, BNL tracks and trends its progress and performance in achieving environmental objectives and performance measures. |
| **Nonconformance and Corrective and Preventive Actions *and Compliance Assurance**** | BNL continues to improve processes to identify and correct problems. This includes implementation of a Lessons Learned Program to prevent recurrences, a robust Self-Assessment Program, and an electronic web-based assessment and action tracking system. |
| **Records** | EMS related records, including audit and training records, are maintained to ensure integrity, facilitate retrieval, and to protect them from loss. |
| **EMS Audit** | To periodically verify that the EMS is operating as intended, audits are conducted. These audits, conducted as 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. |

*The italicized items Pollution Prevention, Community Outreach, and Compliance Assurance are not specific elements of ISO 14001, but they are a part of BNL's enhanced EMS.

conformance with the ISO 14001 Standard in August 2000. This is a formally recognized status option available to organizations that satisfy all the requirements. BNL exceeded the requirements for ISO 14001 self-declaration by undergoing an external audit in October 2000 by an independent registrar. This audit provided assurance to BSA that its system was effectively implemented, and also satisfied a milestone in the DOE/EPA MOA. The BNL organizations that self-declared conformance are: Director's Office/Community Involvement, Government and Public Affairs; Chemistry Department; Physics Department; Instrumentation Division; National Synchrotron Light Source; Energy, Environment, and National Security Directorate; Facilities and Operations Directorate; Environment, Safety, Health, and Quality Directorate; and the Finance and Administration Directorate. A registration audit for the entire Laboratory is scheduled for completion in June of 2001.

**Table 2-2. BNL's Criteria for Significant Environmental Aspects.**

| Environmental Aspect | Criteria for Significant Aspects |
|---|---|
| **Regulated Industrial Waste Generation** | a) Any amount of regulated industrial waste generation. |
| **Hazardous Waste Generation** | a) Any amount of hazardous waste generation. |
| **Radioactive Waste Generation** | a) Any amount of radioactive waste generation. |
| **Mixed Waste Generation** | a) Any amount of mixed waste generation. |
| **Regulated Medical Waste Generation** | a) Any amount of regulated medical waste generation. |
| **Atmospheric Discharges** | a) Any process that requires a point source air permit or inclusion in the Title V permit as an emission unit, or contributes to a regulated emission point.<br>b) Operations or activities that use engineering controls to reduce hazardous air pollutant or radionuclide emissions.<br>c) Radioactive emissions that require monitoring (continuous or confirmatory) per 40 CFR 61 subpart H of the National Emission Standards for Hazardous Air Pollutants. |
| **Liquid Discharges** | a) Radionuclides that are detectable at the point of discharge from the facility.<br>b) Discharges of any of the chemicals listed on the BNL State Pollutant Discharge Elimination System Permit.<br>c) Operations or activities that use engineering controls to reduce the quantity or concentration of pollutant.<br>d) Existence of underground injection control devices. |
| **Storage or Use of Chemicals or Radioactive Materials** (potential for accidental release or contamination) | a) Storage or use of chemicals or radioactive materials requiring engineering controls as specified in BNL procedures.<br>b) System configuration requires back-flow prevention in accordance with the protection.<br>c) Transportation of chemicals or dispersible radioactive materials.<br>d) Storage or use of PCBs as specified in BNL procedures.<br>e) Any underground pipes or ducts that contain chemical and/or radioactive material/ contamination.<br>f) Storage or use in quantities capable of resulting in a reportable spill, as defined in BNL procedures. |
| **Water Consumption** | a) Total organizational water consumption greater than 650,000 gallons per day.<br>b) Continuous (24 hrs/day), permanent (to continue for the foreseeable future) once-through water use greater than 4 gallons per minute (gpm) that discharges to the sanitary sewer system.<br>c) Daily (8 hrs/day), permanent, once-through water use greater than 10 gpm that discharges to the sanitary sewer system.<br>d) Continuous use greater than 10 gpm, or daily use greater than 15 gpm for a period greater than 60 days that discharge to the sanitary sewer system. |
| **Power Consumption** | a) Total organizational power consumption greater than 58 M KWh/yr. |
| **Historical Monuments/ Cultural Resources (groundwater, soil)** | a) Any modification to a historically significant structure (e.g., BGRR, Cosmotron building, and World War I foxholes/trenches).<br>b) Proposed modification to known archaeologically significant area(s) or discovery of archaeologically significant material (lithic scatter, bone, foundations, etc.) |
| **Sensitive/Endangered Species And Sensitive Habitats (including Pine Barrens)** | a) Potential for habitat destruction, harm or harassment within 850 feet of a critical habitat (*recharge basins, vernal pools, natural and manmade ponds and waterways*).<br>b) Disturbance within 100 feet of a regulated wetland (*that is already not identified as a critical habitat*).<br>c) Disturbance within ½ mile of the Peconic River.<br>d) Activity affecting five or more acres of undeveloped land. |
| **Environmental Noise** | a) Exceed ordinance levels [7am-10pm: 55 dba; 10pm-7am: 50 dba (20 min. average)] at property boundary or offsite location. |
| **Historical Contamination (groundwater, soil)** | a) Pre-existing contamination (radiological or nonradiological) causing remedial activities resulting in costs in excess of $50,000. |
| **Soil Activation** | a) Any soil activation. |

*(continued on next page)*

**Table 2-2. BNL's Criteria for Significant Environmental Aspects** *(concluded)*.

| Environmental Aspect | Criteria for Significant Aspects |
|---|---|
| **Transuranic Waste** | a) Generation or potential to generate any radioactive waste stream classified as transuranic waste (i.e., contains greater than 100 nanocuries per gram of trans-uranium isotopes). |
| **Other** | a) Other compliance requirement specific to an organization or aspect that could impact the environment (e.g., asbestos research).<br>b) Any historical or legacy issue. |

Source: *Identification of Significant Aspects and Impacts Subject Area, SBMS*

### 2.1.3 ENVIRONMENTAL STEWARDSHIP POLICY

The cornerstone of an EMS is a commitment to environmental protection at the highest levels of the organization. One of the early steps in the EMS project was strengthening and communicating an environmental policy (reproduced in Figure 1-1 in Chapter 1). The Environmental Stewardship Policy is included in training programs, and is posted throughout the Laboratory and on the BNL website.

The Environmental Stewardship Policy contains the following goals and commitments:

- Achieve and maintain compliance with applicable environmental requirements. These requirements include over 50 sets of local, state, and federal laws and regulations; 16 DOE Directives; seven Executive Orders; and approximately 65 operating permits (see Chapter 3).
- Integrate pollution prevention, waste minimization, and resource conservation into

**Figure 2-2. BNL ISO 14001 Registration Certificate.**

Laboratory activities during the planning, decision-making, and implementation phases. Conserve natural resources. Ensure that environmental emissions, effluents, and waste generation are As Low As Reasonably Achievable (a concept known as "Environmental-ALARA"—see discussion in Section 5.3).

- Define, prioritize, and remedy existing environmental problems. This commitment encompasses removal or treatment of contamination caused by historical practices. It also includes strengthening the environmental monitoring program to ensure that controls designed to protect the environment are working, and to provide early detection of a potential threat to the environment (see Section 2.3.8).
- Emphasize continual improvement. Employ proactive measures to prevent problems. When problems do occur, investigate the root cause and take corrective actions as appropriate.
- Openly communicate with neighbors, regulators, employees, and organizations about program progress and performance (see Section 2.3.10).

#### 2.1.4 STRUCTURE AND RESPONSIBILITY

Once the environmental policy was in place, roles and responsibilities for implementing the EMS needed to be defined. One key to the success of BSA's approach to environmental stewardship has been leadership. At Laboratory meetings and in memorandums, the Director has reaffirmed his personal commitment to environmental protection and his expectation that all staff participate in this way of doing business. BNL has reorganized environmental protection, waste management, restoration, and the community involvement programs to better integrate and elevate these functions within the organizational structure.

BSA also more clearly defined expectations for staff and management. In the past, as is often the case, responsibility for environment, safety, and health had been relegated to the support organizations. Now, under the BSA management model, senior management has communicated their expectation that all line managers take full responsibility for environment, safety, and health performance, and that line managers and staff be held accountable. Every BNL employee was 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. A comprehensive training program for staff, visiting scientists, and contractor personnel was completed (see Section 2.1.6), thus ensuring that all personnel are aware of their environmental responsibilities.

BNL also implemented an Environmental Compliance Representative program in 1998. These environmental professionals are deployed to the field, supporting the research and operational organizations full time. The Environmental Compliance Representatives team with Subject Matter Experts to provide technical support on compliance and pollution prevention, and assist in the development and implementation of the EMS within line organizations.

#### 2.1.5 STANDARDS BASED MANAGEMENT SYSTEM

In order to implement the compliance commitments in the Environmental Stewardship Policy, BNL implemented and continues to improve on a tool called Standards Based Management System (SBMS). SBMS is a web-based system designed to deliver Laboratory-level requirements and guidance to all staff in a user-friendly format. All labwide procedures reside in this system. Up-to-date "Subject Areas" on a variety of environmental topics were developed in 1999 and 2000 by teams of researchers and environmental protection professionals, with input from regulatory agencies. Existing standards for work and research planning and control have been upgraded to ensure that reviews by qualified ES&H staff occur early in the planning process, and that adequate measures to control hazards and risks are incorporated during the design phase. The information provided in SBMS focuses on what staff need to know to do their work in an environmentally responsible manner and translates requirements into a format and language that are easily understandable. Figure 2-3 lists the environmental protection and some of the other key subject areas that support the EMS. During 2000, several of these subject areas underwent a review and improvement cycle.

**ENVIRONMENTAL PROTECTION SUBJECT AREAS**

Drinking Water
Environmental Assessments
Environmental Evaluation of Industrial Processes and Experimental Research
Environmental Monitoring
Groundwater Protection Contingency Plan
Hazardous Waste Management
Identification of Significant Environmental Aspects and Impacts
Liquid Effluents
Mixed Waste Management
NEPA and Cultural Resource Evaluation
Nonradioactive Airborne Emissions
Oil/PCB Management
Pollution Prevention and Waste Minimization
Radioactive Airborne Emissions
Radioactive Waste Management
Regulated Medical Waste Management
Spill Response
Storage and Transfer of Hazardous Materials
Underground Injection Control

**KEY SUPPORT SUBJECT AREAS**

Calibration
Correspondence and Commitment Tracking
Community Involvement in Laboratory Decision-Making
Facility Use Agreements
Graded Approach for Quality Requirements
Hazard Analysis
Integrated Assessment
Internal Controlled Documents
Investigation of Incidents, Accidents, and Injuries
Lessons Learned
Nonconformance, Corrective and Preventive Action
Operational Readiness Evaluation
Records Management
Requesting SBMS Variances
Requirements Management
Roles, Responsibilities, Accountabilities, and Authorities
Training and Qualification

**Figure 2-3. Environmental Management System and Supporting Subject Areas in the Standards Based Management System.** Labwide requirements are contained in SBMS Subject Areas, available online at <https://sbms.bnl.gov>

### 2.1.6 STAFF TRAINING AND AWARENESS

Extensive training on EMS requirements has been provided to staff whose responsibilities involve environmental protection. In total, approximately 12,000 hours of environmental training were provided between 1998 and 2000.

- All staff and visiting scientists working at BNL for more than two months are required to take a computer-based training course developed by BNL to provide a basic level of environmental awareness. The course discusses the EMS, reviews basic environmental requirements, and describes the impacts of noncompliance. Contractors and short-term visitors take a modified training program covering the key points.
- Training sessions were conducted to introduce key staff to the EMS Subject Areas. Subject matter experts from the BNL environmental protection program prepared and presented this training.
- Staff whose work could directly impact the environment were given job-specific training focused on implementing processes and controls to minimize environmental impacts.
- The top three levels of management attended a training program that provided them with an overview of the EMS.
- Teams responsible for coordinating the implementation of the EMS within each organizational unit were provided in-depth training on ISO 14001 requirements and techniques.
- To support the Laboratory's Integrated Assessment Program (see Section 2.1.7), select individuals were trained to perform EMS internal audits.

### 2.1.7 PERFORMANCE BASED MANAGEMENT SYSTEM AND INTEGRATED ASSESSMENT PROGRAM

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

- Significant environmental aspects

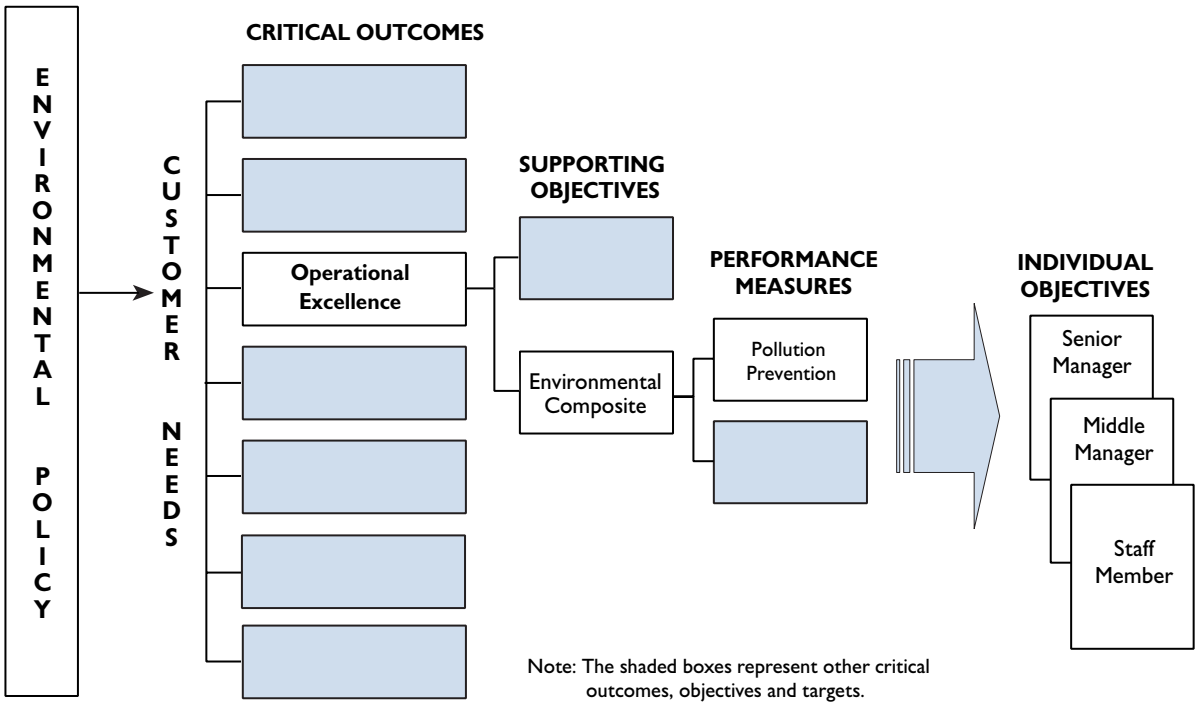


**Figure 2-4. Hierarchy of Environmental Objectives at BNL — an example for operational excellence.**

- Risk and vulnerability (primarily threat to the environment)
- Legal requirements (laws, regulations, permits, enforcement actions)
- Commitments (in the Environmental Stewardship Policy, to regulatory agencies, to the public)
- Importance to DOE, the public, and other stakeholders.

Responsibilities for achieving these expectations are assigned at all relevant levels of the organization, starting with senior management and flowing down to the individual level. The following example illustrates this flow down (also see Figure 2-4). Under the Fiscal Year 2001 Operational Excellence *critical outcome,* BNL had an objective to integrate pollution prevention/waste minimization and resource conservation into all planning and decision making. A related *performance objective* was to reduce hazardous, mixed, and low-level radioactive routine waste streams. The *performance measure* was to reduce all three wastestreams below Fiscal Year 2000 levels. At the Department level, this could translate into an *organizational goal* to develop and implement an action plan to reduce waste generation. A staff member might have an *individual goal* to learn and comply with the Pollution Prevention and Waste Minimization Subject Area requirements, and to purchase environmentally preferable products.

This approach helps employees understand how their work relates to Laboratory-level performance objectives, so they can align their efforts toward achieving BNL missions. It also ensures that Laboratory operations are conducted in accordance with the expectations established by the DOE and BNL management. Through performance based management, BSA focuses environmental management improvement initiatives on addressing the priorities of DOE, regulatory agencies, and the community. Specifically, in 2000, emphasis was placed on developing and implementing the EMS, enhancing the Laboratory's groundwater protection program, improving pollution prevention programs, achieving and maintaining compliance, and expediting environmental restoration.

One key element of the BNL's Performance Based Management Program is routine and systematic assessment processes. The Integrated Assessment Program was established to monitor progress towards achieving high priority improvements, as well as routine expectations such as compliance with environ-

mental regulations. Areas for improvement are identified and tracked to completion.

The primary elements of BNL's Integrated Assessment Program are described below.

*Self-assessment* is the evaluation of internal processes and performance. The approach for the environmental self-assessment program includes evaluating programs and processes within organizations that have environmental aspects. Conformance to ISO 14001 EMS requirements is verified, progress towards 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. Management also conducts assessments to evaluate Laboratory environmental performance from a programmatic perspective, to determine if there are Labwide 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. Laboratory management also routinely evaluates progress on key environmental improvement projects. BNL periodically teams with the local DOE office to perform assessments in order to facilitate the efficiency of assessment activities and ensure that the approach to performing the assessments meets DOE expectations.

*Peer Review* is used to evaluate and independently verify the adequacy of engineering designs and operational controls, as well as the accuracy of documents.

*Independent Oversight* independently verifies the effectiveness and adequacy of the self-assessment programs at the division, department, directorate, and Laboratory levels. Special investigations are also conducted to identify the root causes of problems, corrective actions, and lessons learned.

The Integrated Assessment Program is augmented by programmatic, *external audits* conducted by DOE. Corporate offices of Battelle Memorial Institute and BSA subcontractors also perform periodic independent reviews. As noted in Section 2.1.2, an independent third party conducts ISO 14001 registration audits. BNL is also subject to extensive oversight by external regulatory agencies (see Section 3.14 of Chapter 3). As a result of the MOA with EPA, the Integrated Safety Management verification and validation process conducted by DOE headquarters, DOE-BSA contractual requirements, and the phased implementation of the EMS project, more than 60 audits and self-assessments by both internal and external auditors have been conducted in the last three years to evaluate BNL's EMS and environmental programs. That number does not include self-assessments. For example, in one year, the Collider-Accelerator Department conducted 15 quality assurance assessments; 104 "Tier 1" environment, safety, and health facility walkthroughs; 52, 90-day hazardous waste storage area inspections; and 144 hazardous waste satellite accumulation area inspections. Other organizations within BNL conducted similar types of self-assessments.

Results of all assessment activities related to environmental performance are included, as appropriate, throughout this report.

## 2.2 SPECIAL ENVIRONMENTAL PROJECTS

In addition to the EMS project, the Laboratory developed and funded a set of projects designed to further integrate environmental stewardship into all facets of BNL's missions. Two key projects are described below.

### 2.2.1 THE FACILITY REVIEW PROJECT

BNL has had an active Environmental Restoration Program onsite since 1989, when the site was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (see description in Section 2.3.9 below). However, after a tritium leak from the High Flux Beam Reactor spent fuel storage pool, and strontium-90 contamination emanating from a sump at the inactive Brookhaven Graphic Research Reactor were discovered in 1997, BNL senior management realized that their understanding of potential environmental vulnerabilities was incomplete. To assess and address historical problems, BNL initiated the Facility Review Project in April of 1997.

The Facility Review Project was a comprehensive examination of all site facilities, existing or demolished, to identify any past or current activities with the potential to degrade the environment. During this project, BNL reviewed the entire operating history of the site and more than 900 systems, facilities, and operations including tanks, pipes, sumps,

**Table 2-3. Category, Risk Rank, Number, and Status of Issues Identified in the Facility Review Project, as of December 31, 2000.**

| Category | Rank: Type of Issue | Number | Dispositioned |
|---|---|---|---|
| **75 High Priority Issues** | High Priority: Potential to impact groundwater above drinking water standards | 75 | 56 (75%) |
| **1,175 Operational Issues** (responsible organization still exists) needing further evaluation | Rank 1-3: Potential to impact groundwater, but not above drinking water standards | 176 | 130 (74%) |
| | Rank 4-6: Lower priority, requiring engineering controls or documentation | 999 | 38 (4%) |
| **500 Legacy Issues** (responsible organization does not exist) needing further evaluation | Rank 1-3: Potential to impact groundwater, but not above drinking water standards | 212 | 9 (4%) |
| | Rank 4-6: Lower priority, requiring engineering controls or documentation | 288 | 6 (2%) |
| **Total** | | **1,750** | **239 (14%)** |

cesspools, storage areas, historical discharges, and current and past operating practices. Twenty-eight individuals from fifteen other DOE facilities provided high-level technical and management support during the review. A final report was issued on October 7, 1998 (BNL 1998b).

The report identified 75 issues as the highest priority due to the potential to contaminate groundwater above drinking water standards. Additionally, over 1,675 issues that had the *potential* to impact the environment were identified as needing further evaluation. These were further subdivided into operational and legacy issues. In March 2000 the Facility Review Disposition Project Plan (BNL 2000a) was approved. This three year project provides the mechanisms needed to rank risk, schedule, and disposition the issues identified during the Facility Review Project of 1997. BNL continues to work closely with the Suffolk County Department of Health Services to identify and rank the issues. A database shared between BNL and Suffolk County tracks progress in addressing these issues. See Table 2-3 for a breakdown of the number of issues and their status.

The initial focus has been on issues with the highest potential to have a negative impact on the environment, especially groundwater. Legacy issues will be the focus of efforts in 2001 to accelerate closure.

### 2.2.2 THE PROCESS EVALUATION PROJECT

BNL conducted an extensive evaluation of its experimental and industrial processes to determine compliance requirements, and evaluate and minimize or eliminate potential impact to the environment. One of the MOA requirements was "evaluate all experimental and industrial-type operations at BNL for the purpose of identifying all waste streams produced" on a very aggressive schedule. All high priority processes were to be evaluated within one year, with the balance completed the following year.

BSA realized that this effort could provide an unprecedented level of knowledge of operations, and form a strong technical basis for the EMS and other environmental improvement programs. The scope was expanded by BNL and efforts were managed under the Process Evaluation Project. A process mapping technique was used to develop flow diagrams showing all inputs and outputs to and from processes (see Figure 2-5, an example of a process map for the Boiler Test Facility). Process inputs are the materials used in a process. A multi-media evaluation of outputs (wastes, effluents, and air emissions) from each process was performed. A formal regulatory evaluation of all outputs (waste description, determination, and handling) was conducted to determine compliance requirements. Pollution prevention opportunities and best management practices were identified and are being evaluated. To date:

- Over 145 industrial processes (e.g., machining, painting, electronics) and 1,821 research experiments were evaluated, ahead of the schedule established in the MOA. The final report was submitted to EPA on June 22, 2000 (BNL 2000b).
- Approximately 181 corrective actions were identified. Many of the corrective actions

required sampling and analysis of waste streams formally characterized using process knowledge. As of December 31, 2000, 170 (94%) of the corrective actions have been closed. The remaining 11 are being tracked to closure.

- 188 assessment, prevention, and control measures were identified. These were recommendations for more formal controls such as routine inspections or written procedures. Of these, 98 (52%) have been implemented and closed, and the remainder are being tracked to closure.
- Over 251 pollution prevention opportunities were identified. An example of a pollution prevention opportunity is substitution of nontoxic materials for hazardous chemicals, resulting in the elimination of hazardous waste generation. At the end of the calendar year, 142 (52%) had been evaluated or had already been implemented.

The approximate cost of $1,600,000 for this project was borne by BNL line organizations (60%) and overhead funding (40%). The methods used to evaluate industrial processes and experiments during this project have been integrated into BNL work planning tools, thus institutionalizing the effort and ensuring lasting value. This project is unique in the DOE complex, and probably more comprehensive than what has been done in the private sector. Along with the EMS Project, the Process Evaluation Project was recently selected for a DOE National Pollution Prevention Award for Excellence in Environmental Management. EPA Region II also recommended both projects for inclusion in President Clinton's Library of Accomplishments.

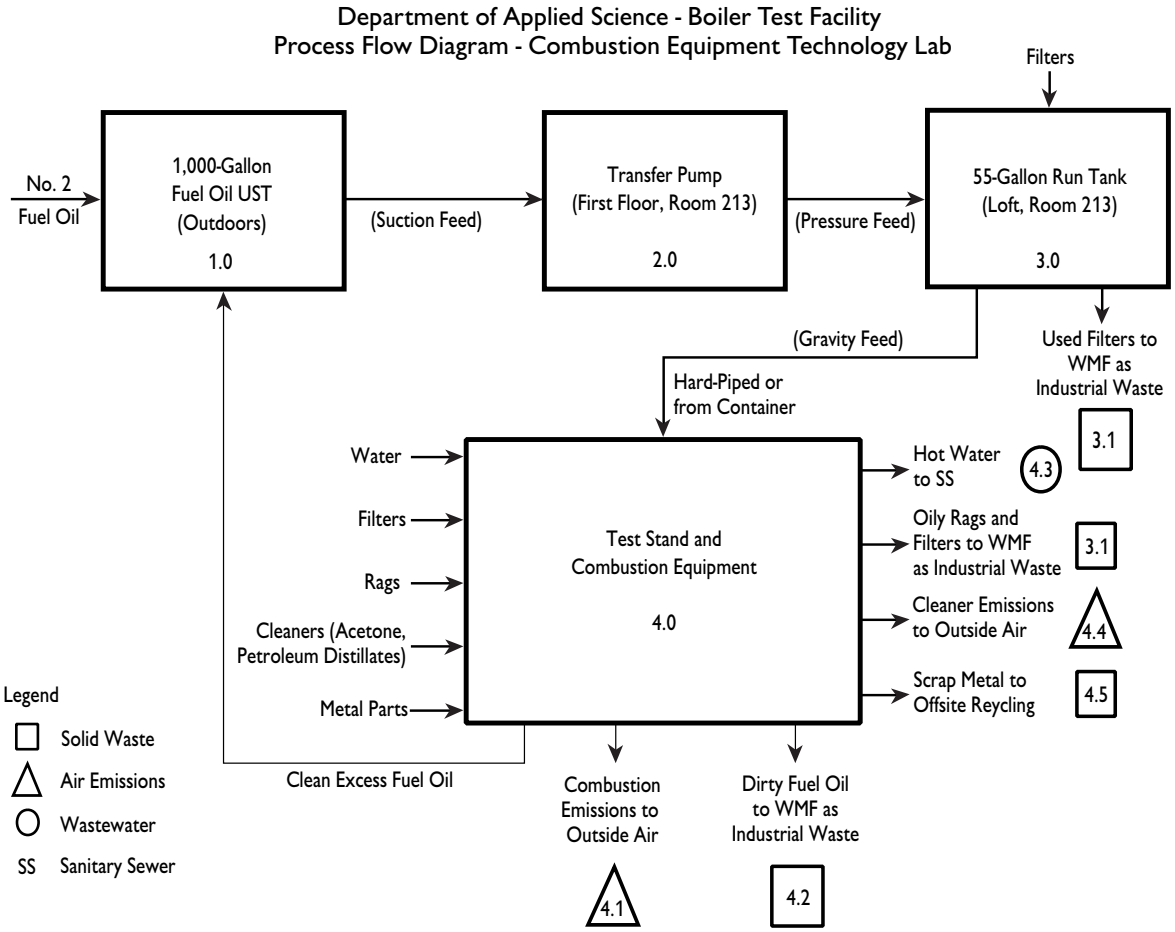


**Figure 2-5. Process Map Example.** BNL has evaluated almost 2,000 industrial and research processes onsite, and produced process maps like this one, showing inputs, outputs and regulatory requirements. (The codes on the figure refer to text in the process evaluation report.)

## 2.3 KEY ENVIRONMENTAL MANAGEMENT PROGRAMS

In addition to the projects described above, a number of programs designed to protect the environment are part of BNL's EMS. Some of the key programs are described below.

### 2.3.1 COMPLIANCE

BNL has an extensive program to ensure full compliance with all applicable environmental regulatory requirements and permits. Some activities, such as the National Emission Standards for Hazardous Air Pollutants compliance program, are routine. Others are special projects or initiatives, such as removing and upgrading storage tanks, upgrading the sanitary sewer system, closing underground injection control devices, retrofitting or replacing air conditioning equipment refrigerants, managing legacy waste, and diverting cooling tower blowdown. See Chapter 3 for a discussion and status of these programs.

### 2.3.2 GROUNDWATER PROTECTION

BNL has developed a Groundwater Protection Management Program that focuses on preventing impacts to groundwater and restoring groundwater quality. Groundwater protection programs at most sites rely solely on groundwater monitoring. In contrast, BNL uses monitoring primarily as a tool to determine whether operational or engineered controls are effectively protecting groundwater. BNL has also developed a Groundwater Protection Contingency Plan that defines an orderly process for taking corrective actions quickly in response to unexpected monitoring results. A key element of that plan and the groundwater program is full and timely disclosure to interested parties. Chapter 7 provides addi-

**Bldg. 860** contains offices for technical and professional staff. Staff are responsible for providing support to the Laboratory to facilitate pick-up, storage, and offsite disposal of hazardous, radioactive, and mixed waste.

## Hazardous Waste Management

**Bldg. 855** is used for the storage of BNL's industrial, hazardous and polychlorinated biphenyl (PCB) solid, liquid, and gaseous wastes. This building was designed and built to provide tertiary containment for stored wastes to prevent environmental contamination should a spill occur. This was accomplished through the use of sealed concrete floors and an impervious liner placed under the building that exceeds regulatory requirements.

Wastes from various research and maintenance activities are typically generated in quantities of five gallons or less. These wastes are stored in containment trays placed on shelves within secondarily contained storage rooms, referred to as lab pack rooms. Wastes stored in these rooms are segregated by hazard class to prevent incompatible materials from reacting.

Some wastes such as liquid wastes from photographic processing and waste oils are collected in 55-gallon drums, and stored in drum storage bays. These bays provide the space needed to maneuver and inspect larger containers. As in the lab pack rooms, wastes are placed into the drum storage bays by hazard class to segregate incompatible materials. Containment is provided by concrete floors (coated with a chemically resistant sealant), which are pitched to sealed collection sumps.

**Figure 2-6. BNL Waste Management Facility.**

## Radioactive Waste Management

**Bldg. 865** is used for the sorting, repackaging, and temporary storage of solid low level radioactive wastes generated by BNL research and maintenance activities. Typical radioactive wastes consist of paper, plastic, glass, and metal. Most radioactive wastes are received at the Waste Management Facility in plastic bags. After receipt, most of these bags are consolidated into metal bins where they may be further consolidated through compaction. Metals, glass, and heavy objects that could puncture a bag are sometimes packaged directly into these bins or other appropriate container.

Prior to shipment offsite, bins containing waste are stored in below grade concrete vaults. Bins are inserted into and removed from these vaults via an overhead crane. Only solid radioactive wastes are stored in Bldg. 865.

## Mixed Waste Management

**Bldg. 870** is used for the storage of mixed wastes. These are wastes that are both hazardous and radioactive. This building is similar in design to the Hazardous Waste Storage Building, Bldg. 855. Most mixed wastes are generated by research activities and are typically in quantities of five gallons or less.

**Building 870** is comprised of storage bays that provide secondary containment. Small waste items are stored within containment trays on shelves in the bays. Typical mixed wastes include radioactively contaminated acids and alcohols, mercury-containing apparatus, and lead used in shielding applications. Mixed wastes are stored in this building prior to offsite treatment and disposal.

tional details about the Groundwater Protection Management Program and monitoring results for 2000.

### 2.3.3 WASTE MANAGEMENT

The goal of BNL's Waste Management Program is safe and efficient management of waste from generation to offsite disposal. The program emphasizes pollution prevention/waste minimization (see Section 2.3.4). It ensures that there is a defined pathway and budget for disposing of any waste generated, and also that BNL complies with applicable regulatory and permit requirements. This includes DOE Order 435.1 (1999), *Radioactive Waste Management*, which requires that all wastes be disposed of within one year of receipt, thus avoiding excess waste accumulation.

BNL has a Waste Management Facility and Wastewater Processing Facility. The Waste Management Facility is a permitted waste storage facility (New York State Department of Environmental Conservation (NYSDEC) Permit No. 1-422-00032/00102-0) consisting of four operations Buildings: 855, 860, 865, and 870. See Figure 2-6 for photographs and a description of the operations in each of these buildings.

**Figure 2-7. The Waste Management Facility Hot Cell.** A hot cell for the management of high-activity radioactive waste was recently constructed in Bldg. 865. The hot cell allows the operator to manipulate and package wastes through the use of mechanical arms. The side walls contain 172,000 lbs. of recycled lead bricks.

Also see Section 4.1.8.1 in Chapter 4 for a description of equipment in Building 865.

The Laboratory completed an upgrade to Building 865 in 2000 with the construction of a hot cell. This project reused 172,000 pounds (77,400 kg) of lead bricks, avoiding $405,000 in materials purchase and mixed waste disposal costs (see Figure 2-7). The hot cell will allow management of high-level radioactive wastes in a safer, more cost-effective manner. Use of the hot cell is expected to begin in 2001 pending the completion of a readiness review.

Mixed wastes present a special disposal challenge, as they contain both hazardous and radioactive constituents. In 2000, BNL shipped over 400 cubic feet (11 cubic meters) of mixed waste offsite for treatment and disposal. Much of this waste had been in storage for years due to the lack of treatment options. During that time, it was monitored by NYSDEC and managed according to the *BNL Site Treatment Plan* (BNL 1997). See Section 2.3.4 for a description of BNL's program to minimize future generation of mixed waste.

The Water Processing Facility (Building 810/811) and the Tritiated Water Evaporator Facility (Building 802) are used to manage liquid wastes. Bulk quantities of radioactive wastewater are stored in tanks at the Building 810/811 facility. The wastewater is stored in permitted tanks for either onsite processing or offsite treatment and disposal. Building 802 processing consists of evaporating tritiated wastewater, which has been treated for the removal of heavy radioisotopes and particulates, under the controls imposed by an existing air permit. In addition to wastewaters managed in Buildings 811 and 802, approximately 68,000 gallons (257,000 liters) of water from the spent fuel pool of the High Flux Beam Reactor were disposed of offsite in 2000 as part of the decommissioning process. (Note: Offsite shipment of all spent fuel from the High Flux Beam Reactor was completed in 1997.)

In addition to the Waste Management and Water Processing Facilities, BNL has nineteen 90-Day Hazardous Waste Accumulation Areas, with the closure of one such area occurring in 2000. There are also approximately 200 Hazardous Waste Satellite Accumulation Areas, where small quantities of hazardous waste are managed at or near the point of generation. Trained staff following standard operating procedures manage the areas.

In 2000, BNL generated the following types and quantities of waste from routine operations:

- Hazardous Waste: 15.7 tons (14.2 metric tons)
- Mixed Waste: 67 cubic feet (1.9 cubic meters)
- Radioactive Waste: 7,885 cubic feet (223 cubic meters)

These quantities represent significant reductions from previous years, as can be seen in Figures 2-8a through f. In 2000, radioactive and mixed waste generation did increase from 1999 levels, due to a more vigorous experimental program at the Alternating Gradient Synchrotron. Construction/demolition wastes, environmental restoration wastes, legacy waste, lead-painted debris, lead shielding, PCB waste, and other wastes determined to be nonroutine are not included in these totals or in Figures 2-8a through 2-8f.

Routine operations are defined as on-going industrial and experimental operations. The picture is not complete however, without consideration of wastes generated from 'nonroutine' or one time events and waste generated from environmental restoration activities. Figures 2-8g, h and i show wastes generated under the Environmental Restoration Program. Waste generation from these activities is growing significantly. This is to be expected as environmental restoration activities transition from remedial investigations and feasibility studies to remedial actions. The purpose of remedial actions is to remove waste or contaminants from the environment. Thus, as the environmental restoration program enters the active cleanup phase, waste volumes from nonroutine operations and remedial actions will continue to rise. The pollution prevention program recognizes this, and will continue to target these waste streams for minimization.

### 2.3.4 POLLUTION PREVENTION/WASTE MINIMIZATION

The EMS provides a mechanism for systematically evaluating and implementing value-added pollution prevention opportunities at the Laboratory. A strong Pollution Prevention/Waste Minimization Program is an essential facet of the EMS. The BNL Pollution Prevention Program goes beyond national and DOE pollution prevention goals and policies, and represents an ongoing effort to make

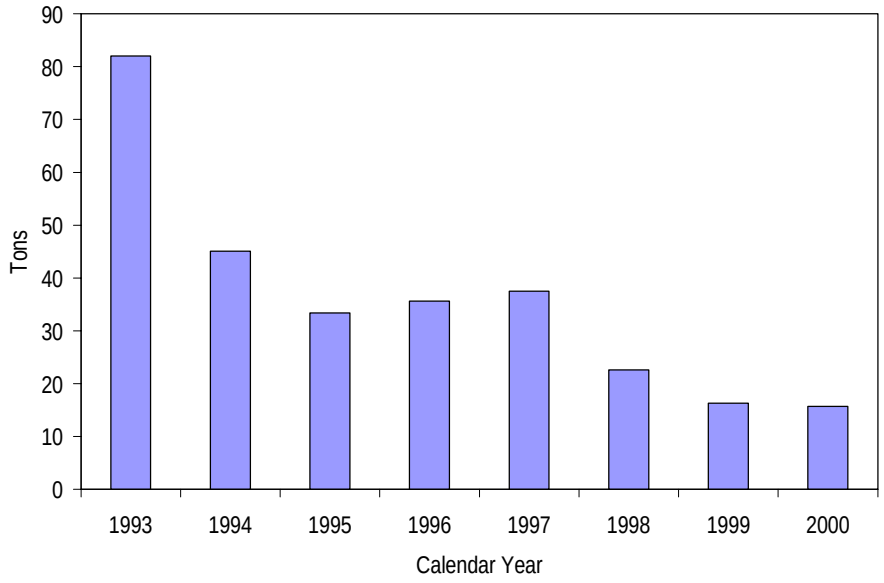


**Figure 2-8a. Routine Hazardous Waste Generation, 1993-2000.**

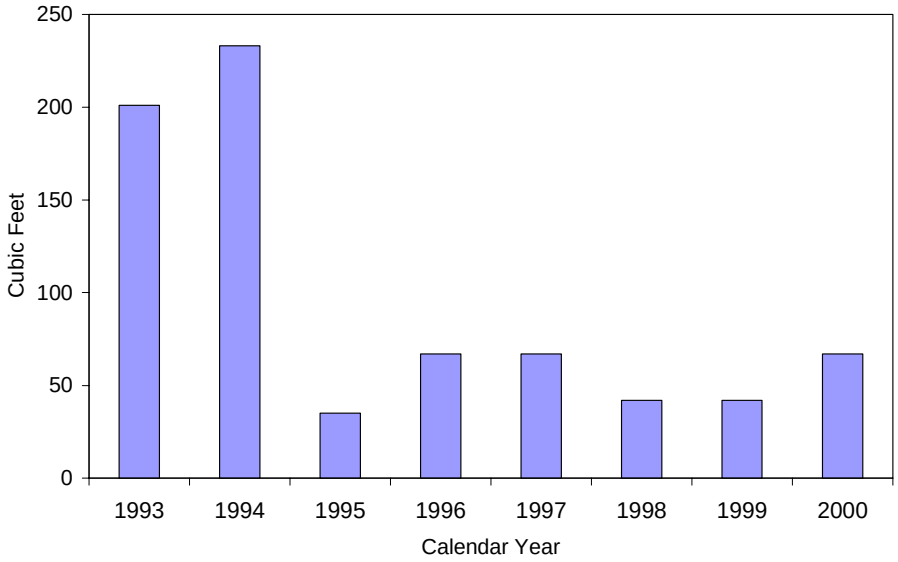


**Figure 2-8b. Routine Mixed Waste Generation, 1993-2000.**

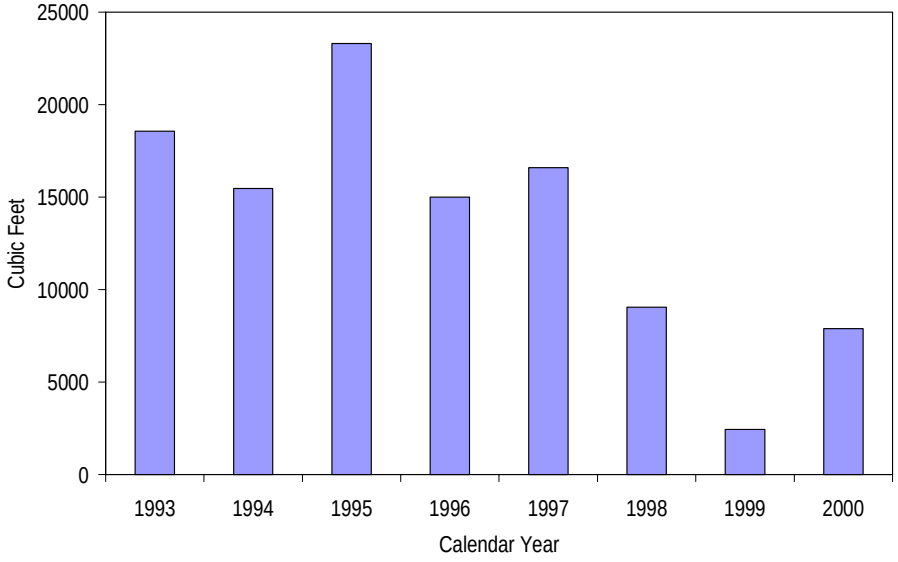


**Figure 2-8c. Routine Radioactive Waste Generation, 1993-2000.**

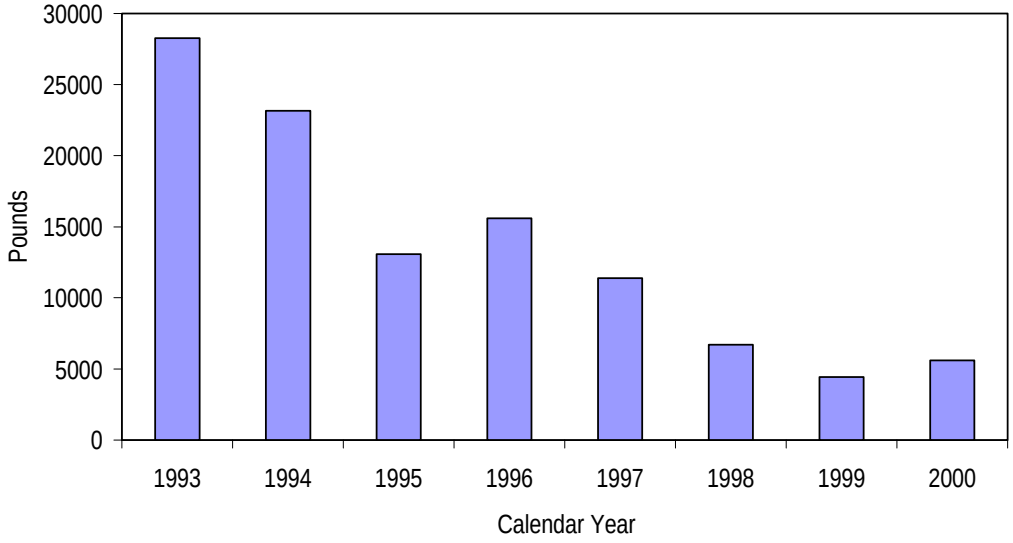


**Figure 2-8d. Hazardous Photographic Waste Generation, 1993-2000.** Hazardous waste from Photography and Graphics Arts has been reduced by nearly 80% since 1993. The reductions were achieved primarily by implementing process and technology changes including conversion to digital photography and digital photographic processing. The required equipment was purchased using pollution prevention funds. The project has had an excellent return on investment.

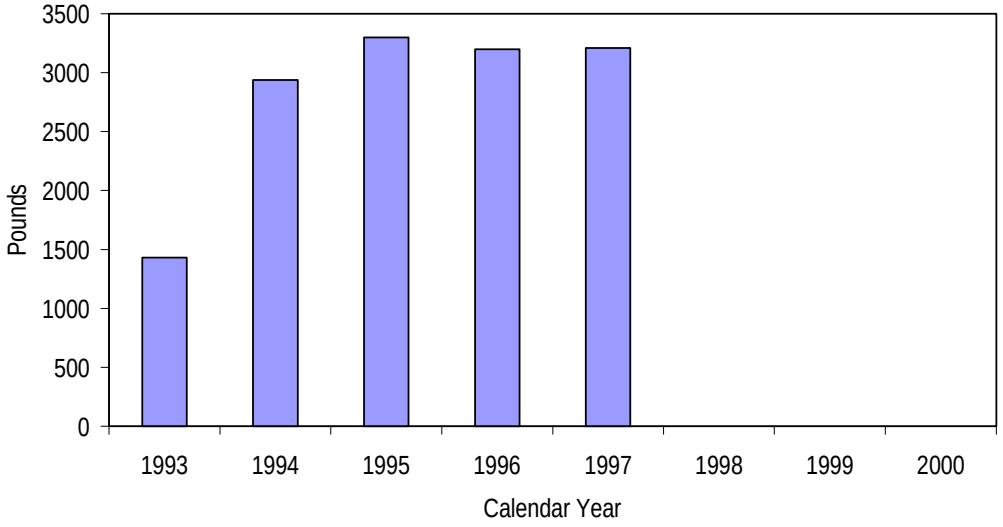


**Figure 2-8e. NSLS Beam Tube Cleaning Waste Generation, 1993-2000.** Prior to 1998, beam tubes used at the National Synchrotron Light Source were cleaned using acids and solvents. The cleanliness specifications for the beam tubes are extremely demanding, and the cleaning operations generated significant quantities of hazardous waste. While planning for an upgrade of the cleaning facility, a pollution prevention opportunity assessment was conducted on the cleaning process. Scientists worked closely with plant engineering and environmental protection staff to develop a completely new cleaning process that relies on ultrasonic agitation using nonhazardous cleaning solutions. The new process ultimately cleaned better than the more hazardous process and completely replaced it, eliminating hazardous waste generation from this operation.

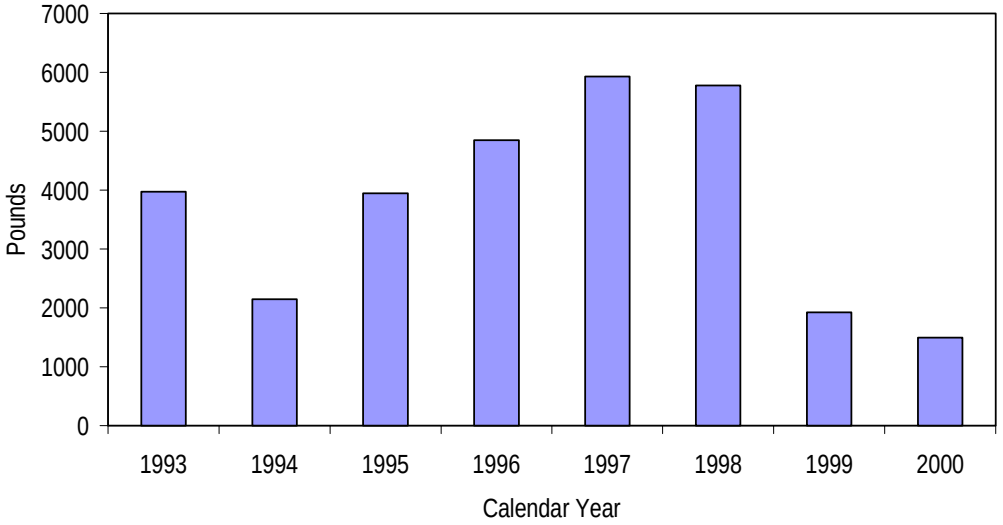


**Figure 2-8f. Hazardous Paint Waste Generation, 1993-2000.** Hazardous waste from painting operations has been reduced by nearly 75% since 1998. Latex paints have replaced oil-based paints in most routine applications, eliminating the need for solvent cleanup and reducing hazardous waste generation.

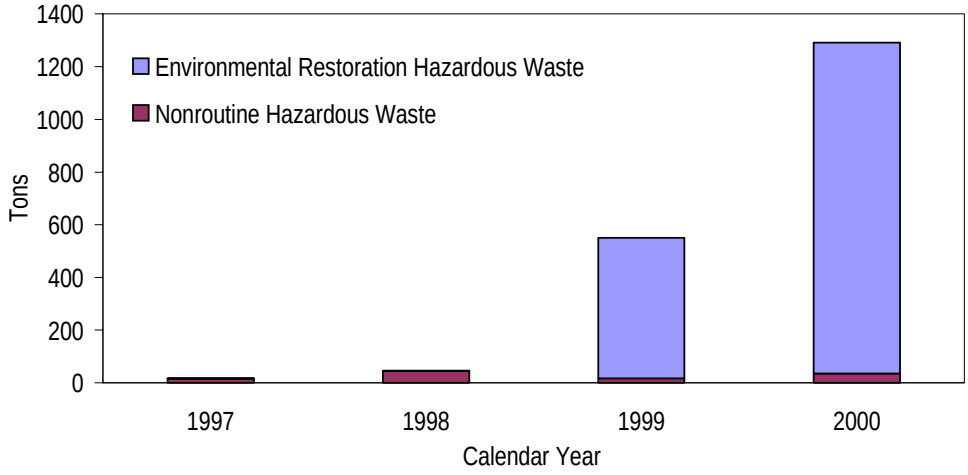


**Figure 2-8g. Environmental Restoration and Nonroutine Hazardous Waste Generation from the ER Program, 1997-2000.** Figures 2-8g, h, and i show the nonroutine waste not included in the totals in Section 2.3.3, as well as other hazardous, mixed, and radioactive wastes generated by the Environmental Restoration Program. As expected, waste volumes have increased dramatically as the environmental cleanup moves from the investigation phase to active remediation.

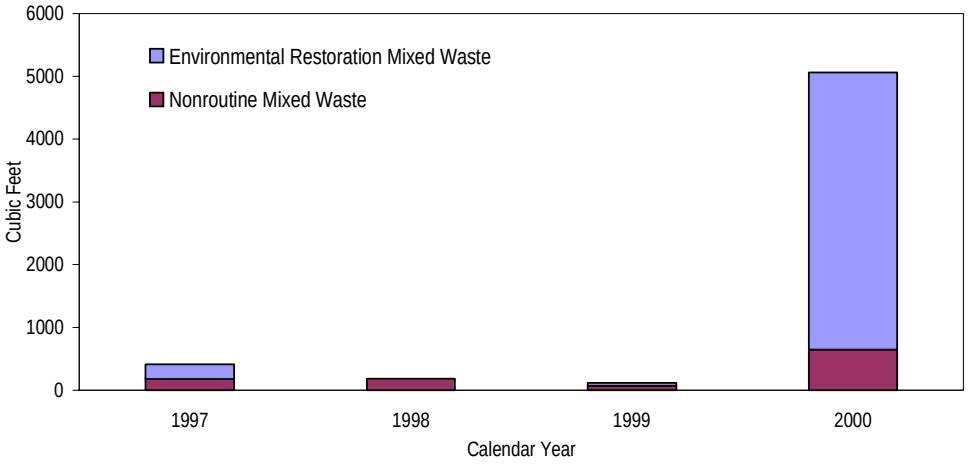


**Figure 2-8h. Environmental Restoration and Nonroutine Mixed Waste Generation from the ER Program, 1997-2000.**

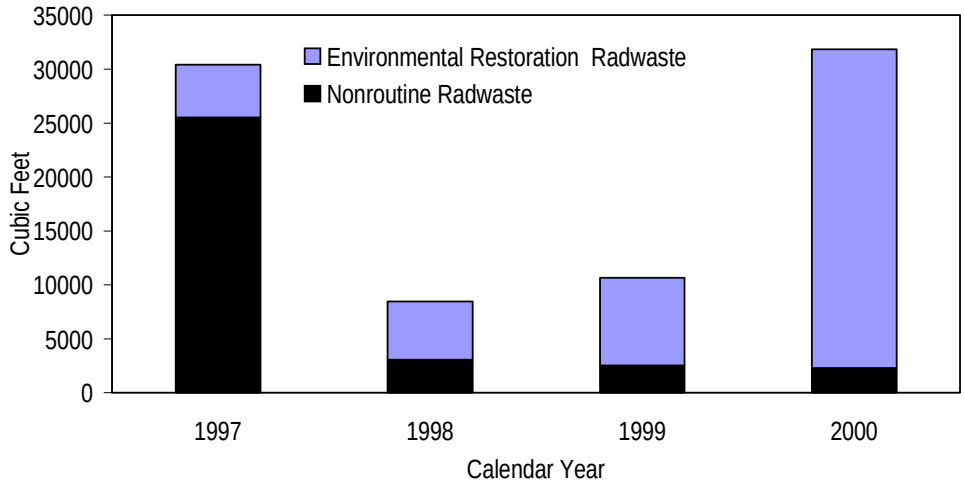


**Figure 2-8i. Environmental Restoration and Nonroutine Radioactive Waste Generation from the ER Program, 1997-2000.**

pollution prevention and waste minimization an integral part of the BNL operating philosophy.

The following are key elements of BNL's Pollution Prevention Program:

- Improving employee awareness of and involvement in pollution prevention goals, plans, and progress.
- Evaluating experimental and industrial processes during the planning stages for ways to eliminate or reduce the use of chemicals, and the generation of waste, liquid effluents, and air emissions where possible at the source.
- Ensuring that environmental effluents, emissions, and wastes are As Low As Reasonably Achievable ("E-ALARA"— See Section 5.3 of Chapter 5 for a discussion of the application of E-ALARA to effluents containing radionuclides.)
- Procuring environmentally preferable products, also known as "affirmative procurement." For example, BNL only purchases paper made from recycled content.
- Conserving natural resources and energy. BNL's energy and water conservation programs are described in Sections 2.3.5 and 2.3.6 of this chapter.
- Employing practices such as reusing and recycling materials, substituting nonhazardous chemicals, and segregating hazardous and nonhazardous wastestreams to avoid cross-contamination.
- Achieving or exceeding BNL and DOE waste minimization, pollution prevention, recycling, and affirmative procurement goals.
- Complying with applicable requirements (e.g., New York State hazardous waste reduction goal, Executive Orders).
- Reducing waste management costs and identifying sustainable funding mechanisms for the evaluation and implementation of pollution prevention opportunities.

Pollution prevention has been successfully integrated into key work planning tools at BNL. Procedures for experimental review, industrial process assessment, nonroutine work planning, and facility design review all incorporate assessment of pollution prevention opportunities. Environmental Compliance Representatives provide expertise to identify and evaluate pollution prevention opportunities. The EMS objective and target setting process provides a platform for opportunity implementation, and the EMS management review process ensures results are measured and tracked. The sustained efforts of the BNL pollution prevention and recycling programs have achieved significant reductions in waste generated by routine operations. From 1993 to 2000, BNL reduced routine hazardous waste generation by 81%, mixed waste by 67% and radioactive waste by 57%.

The Laboratory is also assessing environmental restoration projects for pollution prevention opportunities. For example, DOE expects to save over $800,000 by implementing the recommendations from an assessment on the BGRR decommissioning project. The recommendations are to segregate and reuse soil and debris during excavation, recycle or reuse crushed concrete onsite as fill, reuse lead shielding, and schedule offsite waste shipments with other organizations for bulk cost savings.

BNL has had an active and successful solid waste recycling program for many years. The recycling program involves all employees. In 2000, BNL collected over 336 tons (304.8 metric tons) of paper for recycling. Office staff collect recyclable paper in designated containers at their work stations. Custodial staff collect and consolidate paper to central locations, where it is shipped to the Brookhaven Town recycling facility. In addition to paper, many other kinds of materials are collected under the recycling program, including cardboard, bottles and cans, tires, construction debris, motor oil, scrap metals, lead, automotive batteries, printer and toner cartridges, fluorescent light bulbs, machine coolant, and antifreeze. Table 2-4 shows the total number of tons (or units) of these materials recycled in 2000, along with trends since 1992, when BNL started tracking performance in this area.

BNL has operated a rideshare program since 1995. BNL assists employees in finding suitable rideshare partners by maintaining a ride-matching database. The Laboratory provides a guaranteed ride service for program participants, and subsidizes the cost of a defensive-driving course for employees active in ridesharing partnerships. Some organizations are piloting a flexible work schedule with extended hours, which eliminates one to two days of travel every two weeks.

BNL complies with Executive Order 13148 (2000), *Greening the Government Through Leadership in Environmental Management.* With

**Table 2-4. Recycling Program Summary (CY 2000).**

| Recycled Material | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|
| Mixed Paper | 155 | 136 | 197 | 220 | 106 | 196 | 204 | 370 | 336 |
| Cardboard | 21 | 81 | 164 | 85 | 101 | 103 | 97 | 124 | 132 |
| Bottles/Cans | 12 | 12 | 18 | 11 | 15 | 21 | 22 | 21 | 20 |
| Tires | 9 | 21 | 7 | 11 | 17 | 18.6 | 11.5 | 15.2 | 0[a] |
| Construction Debris | 809 | 495 | 495 | 627 | 837 | 799 | 527 | 352 | 243 |
| Used Motor Oil (gallons) | - | - | 4000 | 3350 | 4275 | 4600 | 3,810 | 3,570 | 3,295 |
| Metals | 201 | 210 | 33 | 153 | 158 | 266 | 64 | 47 | 534 |
| Lead | - | - | - | - | - | 4.4 | 3.7 | 0.7 | 2.5 |
| Automotive Batteries | - | 5 | 0.81 | 0.72 | 6.8 | 4.3 | 2.1 | 1.1 | 2.2 |
| Printer/Toner Cartridges (units) | - | - | - | - | - | - | 1480/175 | 1575/510 | -[b] |
| Fluorescent bulbs (units)[c] | - | - | - | - | 13,664 | 12,846 | 867 | 41,124 | 23,515 |
| Blasocut™ Coolant (gallons) | - | - | - | - | - | - | - | 3,575 | 7500 |
| Antifreeze (gallons) | - | - | - | - | 55 | 276 | 448 | 145 | 110 |
| Tritium Exit Signs (each)[d] | - | - | - | - | - | - | - | - | 185 |

Notes:
All units are tons unless otherwise noted.
- Denotes either not recycled in that year or data not available.
[a] No outlet for the recycling is currently available.
[b] Data not available from recycler.
[c] BNL has been replacing many fluorescent bulbs with non-mercury bulbs that do not contain hazardous materials.
[d] Removed 80 tritium signs in 2000.

the exception of hydroseeding to reestablish damaged landscape, lawn areas are not watered, fertilized, or sprayed with pesticides. This reduces the need for mowing, which in turn reduces air emissions from mowers and tractors. When areas other than lawns are identified for revegetation, they are planted with grasses, wildflowers, or trees native to the Northeast, when available and appropriate. In December 2000, BNL initiated an Integrated Pest Management assessment to evaluate whether there are additional opportunities to reduce pesticide use in agricultural experiments, landscape maintenance, and buildings onsite. The final report will be issued in 2001 and is expected to identify current good practices and opportunities for improvement. (See additional discussion in Chapter 3, Section 3.11.)

Implementation of pollution prevention opportunities, recycling programs, and conservation initiatives has significantly reduced both waste volumes and management costs. In 2000 alone, these efforts have resulted in $2,265,512 in documented cost savings and over 3,367,593 pounds (1.53 million kg) of materials (hazardous, radioactive, mixed, industrial and sanitary) being reduced, recycled, or reused. Table 2-5 describes the projects that were implemented in 2000, and includes the amount of materials reduced, reused, or recycled, along with the estimated cost benefit of each project. If it included water and energy conservation projects, the numbers would be even higher. See Figure 2-9 for reductions in water consumption and Figure 2-10 for reductions in building energy use.

### 2.3.5 WATER CONSERVATION

BNL has a strong water conservation program and has achieved dramatic reductions in water usage since the mid-1990s. The Laboratory continuously 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 process and heating, ventilation, and air conditioning systems, and reuse of once-through cooling water for other systems such as cooling towers. The goal is to reduce the consumption of potable water and reduce the impacts of clean water discharges on Sewage Treatment Plant operations. Figure 2-9 shows the six-year trend of water consumption. In 2000, BNL continued to reduce its water use. A comparison of 1999 and 2000 figures shows a 63,500,000 gallons (240 million liters) reduction

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**Table 2-5. Pollution Prevention, Waste Reduction, and Recycling Projects Tracking System (CY 2000).**

| Waste Description | Reduced, Reused, Recycled or Conserved | Pounds Reduced, Reused, Recycled or Conserved in 2000 | Waste Type | Potential Costs for Treatment and Disposal | Cost of Recycle, Prevention | Estimated Cost Benefit | Project Description |
|---|---|---|---|---|---|---|---|
| Photographic Waste | Segregation | 2,975 | Hazardous Waste | $14,875 | $10,000 | $4,875 | Photography and GraphicArts Division implemented a pollution prevention project funded by the P2 Council that segregates hazardous fixer from non-hazardous developer. This reduces the hazardous waste stream by approximately 350 gal. (2,975 lbs.) annually, avoiding hazardous waste disposal costs of approximately $14,875. |
| Mercury | Reused | 25 | Hazardous Waste | $1,000 | $0 | $1,000 | Medical Department staff filtered and recycled approximately 0.4 gal. of mercury rather than disposing of the mercury as hazardous waste. This avoided disposal costs estimated at $1,000. |
| Chemicals (various) | Reused | 6,000 | Hazardous Waste | $30,000 | $0 | $56,000 | As part of the HFBR facility stabilization project, Reactor Division staff redistributed 1,300 chemicals to researchers around the Laboratory. Reuse of these materials (estimated at 6,000 lbs.) avoided disposal costs of $30,000 and material costs estimated at $26,000. |
| Borated Polyethylene Sheets | Reused | 1,188 | Hazardous Waste | $5,940 | $0 | $5,940 | As part of the HFBR facility stabilization project, Reactor Division staff transferred 1,188 lbs. of borated polyethylene sheets, used as neutron shields, to the National Synchrotron Light Source for reuse, avoiding disposal costs of $5,940. |
| Hydrogen Gas cylinders | Reused | 6,200 | Hazardous Waste | $31,000 | $0 | $31,000 | As part of the HFBR facility stabilization project, Reactor Division staff returned 31 cylinders (estimated at 200 lbs./cylinder) of hydrogen gas to the vendor, avoiding disposal costs of $31,000. |
| Sulfuric Acid | Reused | 20,040 | Hazardous Waste | $100,200 | $0 | $100,200 | As part of the HFBR facility stabilization project, Reactor Division staff contacted the vendor of this material and arranged a return of 1,200 gal. (20,040 lbs.) of sulfuric acid for no cost. This transaction avoided disposal costs of $100,200. |
| Boron Trifluoride Gas-Filled Detectors | Reused | 200 | Hazardous Waste | $1,000 | $0 | $1,000 | Boron trifluoride gas filled detectors were returned to the manufacturer for reuse, avoiding disposal as hazardous waste. Approximately 200 lbs. of material was returned for an estimated savings of $1,000. |
| Lead Acid Batteries | Recycled | 7,250 | Hazardous Waste | $36,250 | $0 | $36,250 | Avoided disposal costs as hazardous waste at $5.00/ lb.,assuming 50 lbs./battery, for a total savings of $36,250. |

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**Table 2-5. Pollution Prevention, Waste Reduction, and Recycling Projects Tracking System (CY 2000)** *(continued).*

| Waste Description | Reduced, Reused, Recycled or Conserved | Pounds Reduced, Reused, Recycled or Conserved in 2000 | Waste Type | Potential Costs for Treatment and Disposal | Cost of Recycle, Prevention | Estimated Cost Benefit | Project Description |
|---|---|---|---|---|---|---|---|
| Ion Exchange Wastewater | Source Reduction | 1,250 | Hazardous and Sanitary wastewater | $2,000 | $500 | $1,500 | Prefilters were added to the deionization system to polish make up 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 wastewaters. The project is estimated to have eliminated 40 gal. of hazardous waste and 200 gal. of sanitary wastewater. Approximately $2,000 in disposal costs are avoided annually. |
| Solvents | Decay in Storage | 85 | Mixed | $10,000 | $0 | $10,000 | Ten one-gallon bottles of High Pressure Liquid Chromatography solvent, characterized as mixed waste due to phosphorus-32 contamination, was allowed to decay in through ten half-lives in accordance with the decay in storage requirements. This allowed the material to be recharacterized and disposed as hazardous waste instead of much more costly mixed waste. This is estimated to have saved $10,000. |
| Shield Block (concrete) | Reused | 668,000 | Radioactive | $1,295,920 | $0 | $1,295,920 | In excess of 600,000 lbs. of shield block were reused onsite by Plant Engineering and Collider Accelerator Department. Approximately 500,000 lbs. of activated shield block went to the Collider Accelerator Dept. for reuse as shielding for beam lines. Approximately 168,000 lbs. of block was reused by Plant Engineering for shielding at the scrap yard. This avoided disposal costs of approximately $1,295,920 (estimate 6,680 cubic feet at $194/cubic foot). |
| Radioactive Wastewater | Reused | 3,400 | Radioactive Wastewater | $14,800 | $0 | $14,800 | As part of the HFBR facility stabilization project, Reactor Division Staff collected and reused approximately 400 gal. (3,400 lbs.) of contaminated water during leak testing of piping systems, avoiding disposal costs of $14,800 ($37.00/gal). |
| Tritium Exit Signs | Source Reduction | 800 | Radioactive | $38,800 | $12,000 | $26,800 | Removed 80 tritium exit signs from service and returned to the manufacturer. Replaced with energy efficient light emitting diode (LED) signs. Project reduced risk of tritium gas release and avoided disposal as radioactive waste. Savings from avoided disposal costs estimated at $38,800 (200 $ft^3$ at $194/$ft^3$), less $12,000 implementation cost, for total savings of $26,800. |

*(continued on next page)*

**Table 2-5. Pollution Prevention, Waste Reduction, and Recycling Projects Tracking System (CY 2000)** *(continued).*

| Waste Description | Reduced, Reused, Recycled or Conserved | Pounds Reduced, Reused, Recycled or Conserved in 2000 | Waste Type | Potential Costs for Treatment and Disposal | Cost of Recycle, Prevention | Estimated Cost Benefit | Project Description |
|---|---|---|---|---|---|---|---|
| Filters | Decay in Storage | 1,920 | Radioactive Waste | $9,312 | $0 | $9,312 | Filters from the air handlers in the Linear Accelerator facility become contaminated with beryllium-7, a short-lived isotope eligible for decay. The filters were allowed to decay for over ten half-lives in accordance with the decay in storage requirements. They were surveyed and released as undetectable for disposal as industrial waste. This avoided disposal costs estimated at $9,312. |
| Antifreeze | Recycled | 935 | Industrial | $4,675 | $0 | $5,675 | Antifreeze was sent for recycling, for an estimated avoided disposal cost of $4,675 (935 lb. at $5.00/lb.) and material savings of $1000. |
| Blasocut™ Machining Coolant | Recycled/Reused | 60,000 | Industrial | $304,800 | $0 | $304,800 | Central Shops Division operates a recycling system that reclaims Blasocut™ machining coolant and supplies it labwide. 7,500 gallons of Blasocut lubricant were recycled in 2000. Recycling involves aeration, centrifuge, and filtration. Avoids cost of disposal as industrial waste ($5.00/lbs.), plus an avoided cost of procurement of 6 drums of concentrate ($800/drum) for a total savings of $304,800. Cost of recycle is estimated to be the same as cost of procurement and preparation of proper dilution for use. |
| Used Motor Oil | Recycled | 23,065 | Industrial | $115,325 | $0 | $115,325 | Estimate avoided disposal cost of $115,325 (23,065 lbs. at $5.00/lb.). |
| Office Paper | Recycled | 672,940 | Sanitary | $26,918 | $0 | $26,918 | Estimate $80/ton for disposal as trash. |
| Cardboard | Recycled | 263,960 | Sanitary | $10,558 | $0 | $10,558 | Estimate $80/ton for disposal as trash. |
| Scrap Metal | Recycled | 1,069,340 | Sanitary | $42,774 | $0 | $42,774 | Estimate $80/ton for disposal as trash. |
| Bottles/Cans | Recycled | 39,020 | Sanitary | $15,608 | $0 | $15,608 | Estimate $80/ton for disposal as trash. |
| Construction Debris | Recycled | 486,440 | Sanitary | $19,458 | $0 | $19,458 | Estimate $80/ton for disposal as trash. |
| Cooling Tower Packing | Reused | 11,880 | Sanitary | $2,000 | $0 | $2,000 | As part of the HFBR facility stabilization project, Reactor Division Staff returned 192 $ft^3$ (11,880 lbs.) of cooling tower packing material to the vendor at no cost, avoiding handling and landfill charges estimated at $2,000. |

*(continued on next page)*

**Table 2-5. Pollution Prevention, Waste Reduction, and Recycling Projects Tracking System (CY 2000)** *(concluded).*

| Waste Description | Reduced, Reused, Recycled or Conserved | Pounds Reduced, Reused, Recycled or Conserved in 2000 | Waste Type | Potential Costs for Treatment and Disposal | Cost of Recycle, Prevention | Estimated Cost Benefit | Project Description |
|---|---|---|---|---|---|---|---|
| Supplies and Equipment | Reused | 11,000 | Sanitary | $126,000 | $0 | $136,000 | As part of the HFBR facility stabilization project, Reactor Division staff sought users for supplies and equipment through placement of ads in the *Brookhaven Bulletin*. This resulted in the transfer of approximately $126,000 worth of supplies and avoided disposal costs of approximately $10,000. |
| Granular Charcoal | Reused | 9,680 | Sanitary | $6,300 | $0 | $6,300 | As part of the HFBR facility stabilization project, Reactor Division staff returned twenty-one 55-gallon drums (9,680 lbs.) of granular activated charcoal to the vendor at no cost, avoided handling and landfill charges estimated at $6,300. |
| **Totals** | | **3,367,593** | | **$2,265,513** | **$22,500** | **$2,280,013** | |

in water use for 2000 alone. The total annual reduction since 1995 is 600,000,000 gallons (2.3 billion liters).

Installing a temperature-controlled throttling valve for process cooling at the AGS resulted in the most significant savings. By measuring the outlet temperature of the cooling water, the valve is either opened or closed to minimize water flow and achieve optimal temperatures. The benefits of this change, which was completed in 1999, were fully realized in 2000.

There are numerous environmental and economic benefits of this change. First, the switch to domestic water increased heat exchanger efficiency, reduces exchanger down time, and eliminates the need to add corrosion inhibiting chemicals. A secondary benefit of the AGS water conversion project was reduced equipment maintenance and improved water discharge quality. Under the former cooling system, main magnet heat exchangers at the AGS were back-flushed several times each week to remove iron deposits. Using potable water, these exchangers are now backflushed no more than twice a year. Performance of the recharge basin that receives this discharge has improved as a result. The basin was previously scraped every 12-18 months to remove iron scale that clogs soil pores and prevents leaching. The basin has not been scraped in three years and is still fully operational, with no signs of excess water accumulation. Scraping the basin generates 1,000 cubic yards (765 cubic meters) of iron-rich soil that presents disposal problems.

Another key project, which was initiated in 2000, is connecting Building 555 to the central chilled water system. Chilled water will be used to cool the heating, ventilation, and air conditioning systems and replace the old cooling towers. Not only will this project result in less water use, but it will also reduce chemicals stored and used for corrosion control. Once fully connected to the central chilled water system, the cooling towers will be taken out of service.

### 2.3.6 ENERGY MANAGEMENT AND CONSERVATION

BNL has over 4 million square feet (371,600 square meters) of building space. Many BNL scientific experiments use particle beams generated and accelerated by electricity with the particles controlled and aligned by large electro-magnets. Fuel and natural gas are used to

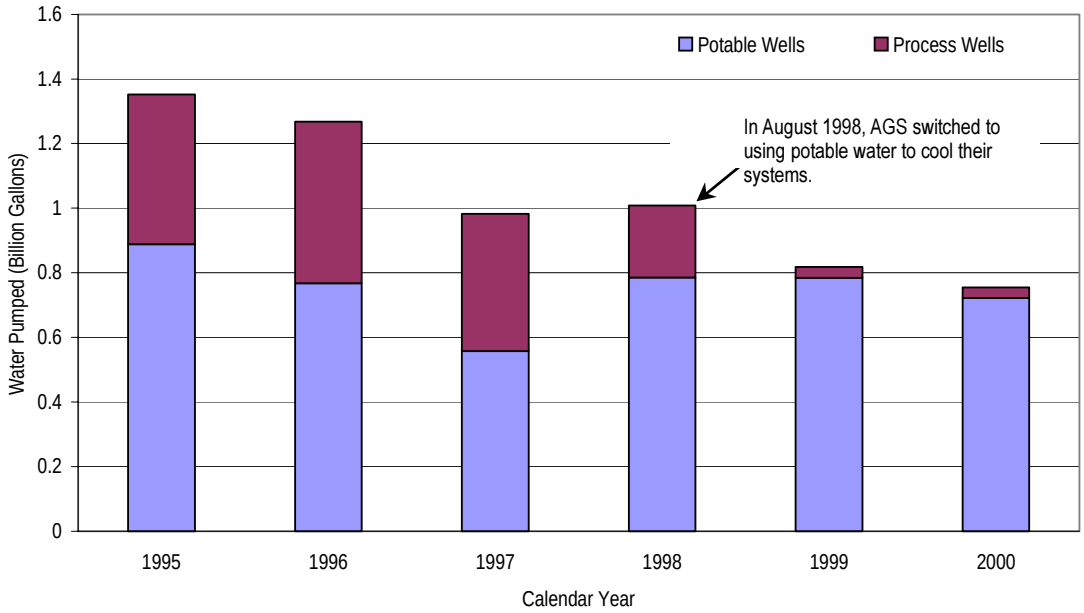


**Figure 2-9. Water Consumption Trend, 1995-2000.**

produce steam at the Central Steam Facility. In 2000, BNL used over 300,560,811 KWh of electricity, 1,335,157 gallons (5.1 million liters) of fuel oil and propane, and 475,150,000 cubic feet (13.5 cubic meters) of natural gas. Natural gas use started in FY 1997, and is displacing some of the historic fuel oil use. (See additional information on fuel use in Chapter 5.)

In 2000, the Laboratory spent approximately $19 million for energy. To help deal with large energy expenditures, as well as meet DOE goals for energy conservation, BNL's Energy Management Group was established in 1979. It works to reduce BNL's energy use and costs by identifying cost-effective energy efficiency projects, monitoring energy use and utility bills, and assisting in obtaining the least expensive energy sources possible. It is responsible for the development, implementation, and coordination of BNL's Energy Management Plan.

In 2000, several energy management projects were completed. These include a Controls System Optimization Project, which recommissioned the existing energy management control

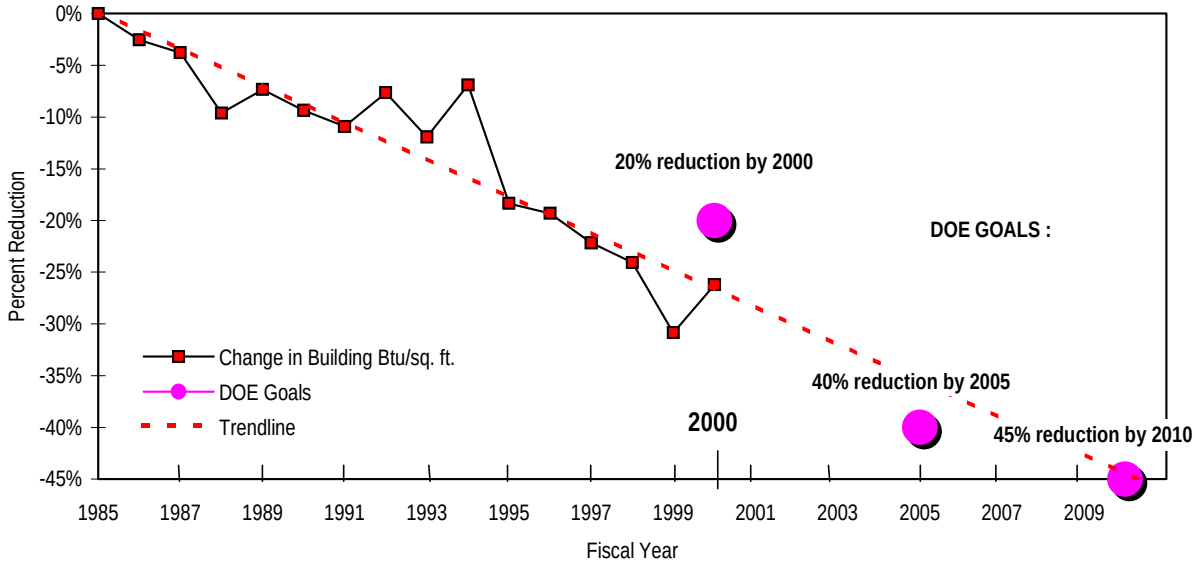


**Figure 2-10. Building Energy Performance Since 1985.**

system in five buildings, and installation of a side-stream filter at the Central Chilled Water Facility to improve heat transfer and energy efficiency. In addition, BNL continues to expand the energy management control system in new buildings and building additions. By controlling temperature set points and operating schedules, energy management control systems can reduce a building's energy use by at least 10%.

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 improve federal building design in order to reduce energy consumption per square foot. Current goals are to reduce energy consumption per square foot, relative to 1985, by 20% in 2000, 40% by 2005 and 45% by 2010. BNL more than met the DOE national goal for 2000, with energy use per square foot 26% less than in 1985 (see graph in Figure 2-10). Energy use rose from 1999 to 2000 because of the weather and start-up of the RHIC facility.

A lighting project to replace exit signs containing tritium with light emitting diode signs was also completed in 2000. Eighty tritium signs were taken out of service and returned to the manufacturer, eliminating the risk of radioactive release. The manufacturer exchanged the tritium signs with highly efficient, nonradioactive, light emitting diode signs which use only three watts of electricity and have an expected useful life of 80 years.

BNL's Energy Management Group also orchestrated a demonstration and test of fuel cells at the Laboratory in 2000. In cooperation with the Long Island Power Authority, Plug Power, and New York State Energy Research & Development Authority, three fuel cells were installed at the Laboratory as part of DOE's strategic effort to develop alternatives to large-scale power plants.

### 2.3.7 NATURAL AND CULTURAL RESOURCE MANAGEMENT

The Laboratory continues to develop, enhance, and implement its natural resource program, building on a foundation established by the Wildlife Management Plan. Over the past year, BNL has begun to develop a cultural resource program 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 two programs, refer to Chapter 6.

### 2.3.8 ENVIRONMENTAL MONITORING

The Laboratory has established a comprehensive Environmental Monitoring Program. This program identifies potential pathways for exposure of the public and the environment, as well as evaluating what impact BNL activities may be having on the environment. It also ensures compliance with environmental permit requirements.

The monitoring program is reviewed, and revised as necessary, 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 upon the review of previous analytical results. As required under DOE Order 5400.1 (1988), BNL's *Environmental Monitoring Plan, Triennial Update* (BNL 2000b) outlines annual sampling goals by specific media and frequency. The 2000 plan also specifies the data quality objectives associated with the monitoring program.

There were a total of 6,004 sampling events of groundwater, potable water, precipitation, air, plants and animals, soil, sediment, and discharges in 2000 under the Environmental Monitoring Program, as shown in Table 2-6. That number does not include samples taken to characterize wastes for disposal purposes nor nonroutine samples collected in support of restoration characterization activities. Specific sampling programs for the various media are described further in Chapters 4 through 7.

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

#### 2.3.8.1 COMPLIANCE MONITORING

Compliance monitoring is conducted to ensure that wastewater effluent, air emissions, and groundwater monitoring data comply with limits in regulations and permits 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:

- *Air emissions monitoring* is conducted at reactors, accelerators, and other radiological

**Table 2-6. Summary of BNL Sampling Program Sorted by Media (CY 2000).**

| Environmental Media | Total # of Sampling Events* | Purpose |
|---|---|---|
| Groundwater | 2,530 | To evaluate impacts of past and present operations on groundwater quality, under the Environmental Restoration, Environmental Surveillance and Compliance programs. |
| Onsite Recharge Basins | 178 | Recharge basins used for wastewater and stormwater disposal are monitored in accordance with discharge permit requirements and for environmental surveillance purposes. |
| Potable Water | 231 | 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 and for environmental surveillance purposes. |
| Sewage Treatment Plant | 1,007 | The STP influent and effluent and several downstream Peconic River stations are monitored routinely for organic, inorganic, and radiological parameters to assess BNL impacts on the estuary. The number of samples taken depends on flow—e.g., samples are scheduled for collection at Station HQ three times per week, 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 and direction, temperature and atmospheric stability, to help model atmospheric transport and diffusion of radionuclides. |
| Air - Tritium | 369 | Silica gel cartridges are used to collect atmospheric moisture for subsequent tritium analysis. These data are used to assess tritium levels downwind of the reactors. Due to several years of nondetectable measurements, and the shutdown of the HFBR, monitoring was reduced from weekly to monthly in several areas of the site in 1999. See discussion in Chapters 4 and 8. |
| Air - Particulate | 504 | Gamma analysis is performed on samples of particulate matter collected from air samples. The purpose is determine whether there has been impact from BNL operations. |
| Air - Charcoal | 158 | Charcoal samples are used to assess for radioiodines, which could be released in reactor emissions. |
| Fauna | 90 | Fish, deer and small mammals are monitored to assess impacts on wildlife associated with past (or current) BNL operations. |
| Flora | 63 | Since the primary pathway from soils to fauna is via ingestion, vegetation is sampled to assess uptake of contaminants by plants and hence tofauna. This number includes 33 samples taken of farm produce. |
| Soils | 347 | Soil samples are collected from adjacent farms and other local areas to confirm that Laboratory emissions have no impact on surrounding areas. Soil samples are also collected in conjunction with Environmental Restoration investigative work. |
| Miscellaneous | 519 | Samples are collected periodically from manholes and other locations to assess compliance with regulatory requirements. This number includes samples taken by the ESD field sampling team for Plant Engineering (e.g., collected during sewer line cleanouts). |
| **Total Number of Sampling Events in 2000** | **6,004** | This number includes all the samples identified in the EMP (BNL 2000b) plus samples collected by the ESD field sampling team as special requests. The number does not include samples collected to monitor Environmental Restoration air and water treatment system processes, or samples taken by Waste Management Division, waste generators or Environmental Compliance Representatives for waste characterization purposes. |

* In one sampling event, multiple samples may be collected from a single location. For example, a separate sample for tritium, gross-alpha beta, and VOC's may be collected from a groundwater monitoring well during one event.

emission sources, as well as the Central Steam Facility. Real-time, continuous emission monitoring or periodic sample collection equipment is installed and maintained at these facilities, as required by permit conditions. Analytical data are routinely reported to the permitting authority. See Section 3.5 of Chapter 3 for details.

- *Wastewater discharge monitoring* is performed at the point of discharge to ensure that the effluent complies with release limits in BNL's permits. Fifteen point source discharges are monitored under the BNL program: three under the Environmental Restoration Program and twelve under the State Pollutant Discharge Elimination System permit. As required by permit conditions, samples are collected daily, weekly, monthly, or quarterly and monitored for organics, inorganics, and radiological parameters. Monthly reports that provide analytical results and an assessment of compliance for that reporting period are filed with the permitting agency. See Section 3.6 of Chapter 3 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 Central Steam Facility, and the Resource Conservation and Recovery Act permit for the Waste Management Facility. Extensive groundwater monitoring is also conducted under the ER program as required under the Records of Decision for many of the Operable Units or Areas of Concern. See Chapter 7 for details. Additionally, to ensure that the Laboratory maintains a viable potable water supply, groundwater is monitored as required by the New York State Department of Health. See Section 3.7 of Chapter 3 for details on potable water supply monitoring programs and results.

#### 2.3.8.2 RESTORATION MONITORING.

Restoration monitoring is performed to determine overall impacts of past operations, to delineate the real extent of contamination, and to ensure that removal actions are effective and remedial systems are performing as designed (under the Comprehensive Emergency Response, Compensation and Liability Act [CERCLA] and Resource Conservation and Recovery Act).

This program typically includes collection of soil and groundwater samples in order to determine the lateral and vertical extent of the contaminated area. Samples are analyzed for organics, inorganics, and radiological contaminants, and the analytical results are compared with guidance, standards or background concentrations. Areas where impacts have been confirmed are fully characterized, and if necessary, remediated to mitigate continual impacts. Follow-up monitoring of groundwater is conducted in accordance with a Record of Decision.

#### 2.3.8.3 SURVEILLANCE MONITORING.

Surveillance monitoring is conducted to further monitor what impact, if any, BNL operations have on the environment (pursuant to DOE Order 5400.1). The focus of the environmental surveillance program is assessing potential environmental impacts resulting from routine facility operations. This program includes collection of ambient air, surface water, groundwater, flora, fauna, and precipitation samples. Samples are analyzed for radiological, organic, and inorganic contaminants. Additionally, routine reviews of data collected by thermoluminescent dosimeters (devices to measure radioactive exposure) placed onsite and offsite are performed under this program.

*Control samples* (also called background or reference samples) are also collected on and off the site to compare BNL results to areas that could not have been impacted 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 remainder of this Site Environmental 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.

### 2.3.9 ENVIRONMENTAL RESTORATION

In 1980, the U.S. Congress enacted CERCLA to ensure that sites with historical

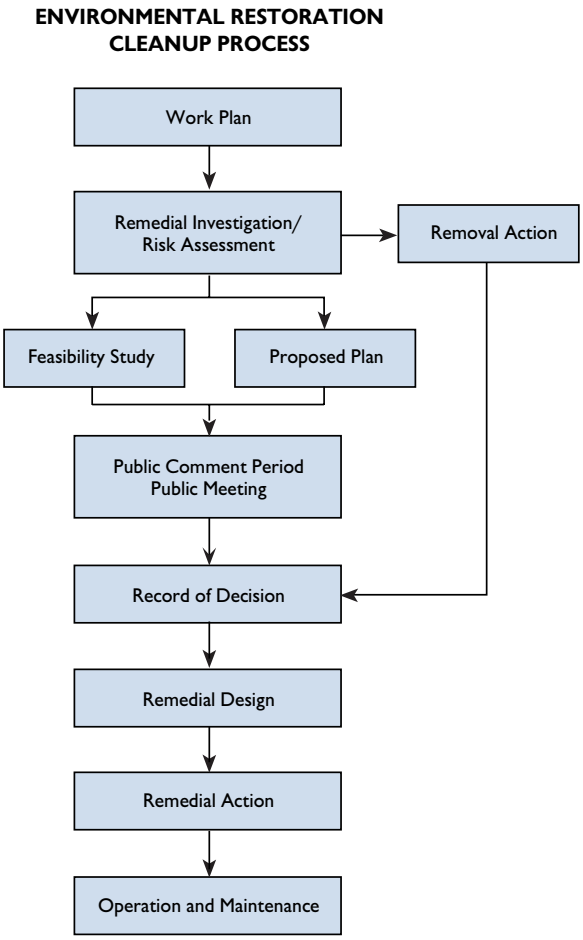


**Figure 2-11. CERCLA Process.**

contamination were cleaned up. As part of CERCLA, EPA established the National Priorities List, also known as the NPL. The NPL is a list of sites nationwide where cleanup of past contamination is required. BNL is listed on the NPL, along with 31 other sites located on Long Island (including 16 in Suffolk County) (see <http://www.epa.gov/superfund/sites/npl/ny.htm>). The majority of contamination at BNL is associated with past accidental spills and practices for chemical and radiological material handling, storage, and disposal.

BNL follows the CERCLA process (see Figure 2-11), which includes:

- conducting a *Preliminary Assessment* (review of historical documents, interviews with employees, site reconnaissance),
- conducting a *Site Inspection* (which often includes sampling),
- conducting a *Remedial Investigation* (to characterize the nature and extent of contamination and assess the associated risks),
- preparing a *Feasibility Study* and *Proposed Plan* (to list and evaluate remedial action alternatives and present the proposed alternative),
- issuing a *Record of Decision* (the remedy/corrective action agreed to by DOE, EPA, and NYSDEC), and
- performing the *Remedial Design/Remedial Action* (which includes final design, construction specifications, and carrying out the remedy selected).

At each step, EPA distinguishes between sites that do or do not require further action, based on potential threat to human health and the environment. An expedited cleanup action, called a *Removal Action*, can also be conducted. This requires an *Engineering Evaluation/Cost Analysis*, which evaluates and recommends specific cleanup actions. The selected action is then documented in an *Action Memorandum*, the equivalent of a Record of Decision.

The goal of the BNL's Environmental Restoration Program is to complete onsite cleanup activities and install all groundwater treatment systems by 2006 or earlier. The Laboratory has made substantial progress in characterizing and removing sources of contamination (e.g., underground tanks) and in treating or removing the groundwater and soil contamination resulting from past disposal practices. It has also worked to advance the decontamination and decommissioning of the Brookhaven Graphite Research Reactor (BGRR).

Groundwater cleanup efforts have included monitoring existing groundwater wells; installing new, permanent groundwater monitoring wells; capping three onsite landfills; installing and operating groundwater treatment systems both on and off Laboratory property; and coordinating the extension of public water service in nearby neighborhoods. During 2000, 1,001,342,000 gallons (3.8 billion liters) of groundwater were treated and 700 pounds (318 kg) of volatile organics were removed. Since the first groundwater treatment system started operating in December 1996, approximately 2,300 pounds (1,040 kg) of volatile organic compounds have been removed from more than 3,066,842,400 gallons (11.6 billion liters) of groundwater. See Chapter 7 for more information.

Soil cleanup efforts have included the excavation and sorting of debris and soil from 55 waste pits and the removal of 2,640 cubic yards (2020 cubic meters) of landscaping soils from

**a and b.** Substantial progress was made in 2000 in the decommissioning of the BGRR. For example, five sections of the aboveground ducts (left) were removed from the support structure and lowered to the ground for cutting and packaging prior to offsite disposal. In March, the Pile Fan Sump (right) and surrounding soils were excavated.

**c.** Excavation of isolated areas of contaminated landscaping soil began in May 2000 and was completed in September. Excavated areas were backfilled with clean soil and reseeded.

**d.** To protect groundwater beneath the Brookhaven Linac Isotope Producer, silicon grout was injected beneath the building in May and June 2000 to encapsulate activated soil.

**e.** In February 2000, DOE and BNL proposed a cleanup plan for Operable Unit V, which includes the BNL Sewage Treatment Plant and the Peconic River. Opportunities for public comment included public meetings and workshops.

**f.** In August 2000, a public meeting was held to discuss a pesticide ethylene dibromide. A groundwater treatment system will be installed to remove this chemical from the aquifer.

**Figure 2-12. Environmental Restoration Actions Taken During 2000.**

various areas on the Laboratory site. In addition, substantial progress has been made in shipping materials from an onsite storage yard to offsite disposal facilities in preparation for the cleanup of BNL's former Hazardous Waste Management Facility.

Progress at the BGRR has included excavation of the Pile Fan Sump and surrounding soils, and the removal and offsite disposal of five large cooling fans from the reactor's fan house. A Removal Action to address the reactor's aboveground air ducts is also underway.

#### 2.3.9.1 ENVIRONMENTAL RESTORATION PROGRAM PROGRESS BY OPERABLE UNIT (OU)

Historical facility records and sampling have been used to determine where contamination might be present on the site today. These areas were geographically grouped into Operable Units (OU) (see *Areas of Concern at BNL, Upton,*

**Table 2-7. Environmental Restoration Program Progress by Operable Unit (CY 2000).**

| Operable Unit/ Project | Description and *Contamination Type* | Environmental Restoration Program Actions in 2000 |
|---|---|---|
| OU I | Former Hazardous Waste Management Area, Landfills, and Disposal Pits<br>*Radiological Soil Contamination, primarily cesium-137* | ♦ Excavated and shipped 2,640 cubic yards of contaminated landscape soils.<br>♦ Completed restoration of excavated areas.<br>♦ Completed Landfill Monitoring Report for EPA/DEC review.<br>♦ Shipped wastes from four Underground Storage Tanks at Bldg. 811.<br>♦ Shipped five rail cars with the remaining glass holes debris to Envirocare (a permitted Treatment, Storage, and Disposal Facility).<br>♦ Issued Request for Proposal for remedial actions at Bldg. 811 and Bldg. 650.<br>♦ Continued operation of the OU I south boundary pump and treat system (formerly known as RA V). |
| OU II/VII | AGS Scrapyard & Soil Contamination<br>*Radiological Soil Contamination, primarily cesium-137 & strontium-90* | ♦ Applied a silicon grout barrier to soil beneath the Brookhaven Linac Isotope Producer (BLIP). Completed barrier installation in June 2000.<br>♦ Issued draft completion report for BLIP project. |
| OU III | Potable Supply Wells/ Spills<br>*Chemical and radiological groundwater contamination primarily VOCs, tritium & strontium-90* | ♦ Completed construction of groundwater treatment system for volatile organic compounds (VOCs) in the Former Scrapyard & Drum Storage Area south of Bldg. 96. Completed startup testing of the system.<br>♦ Excavated and shipped approximately 1,100 cubic yards of PCB-contaminated soil from the Former Scrapyard & Drum Storage Area.<br>♦ Awarded construction contract for the Middle Road groundwater treatment system.<br>♦ EPA approved the OU III Record of Decision on June 20, 2000.<br>♦ Continued operation of the carbon tetrachloride pump and treat system.<br>♦ Continued operation of the OU III south boundary groundwater pump and treat system.<br>♦ Removed 1,378 lbs. of VOCs from the aquifer using all treatment systems.<br>♦ Continued installation of Geoprobes™ to monitor HFBR tritium plume.<br>♦ Continued the low-flow pumping of tritiated groundwater along Temple Place.<br>♦ Continued operation of tritium pump and recharge system until September 29, 2000, when the system was placed on standby. |
| OU IV | Central Steam Facility Spill & Bldg. 650 Sump Outfall<br>*Chemical and radiological soil and groundwater contamination* | ♦ Completed monitoring of the Air Sparge/Soil Vapor Extraction System (AS/SVE). Submitted formal petition for shutdown of the system.<br>♦ Continued interim remedy monitoring for the Bldg. 650 Sump and Sump Outfall Area. |
| OU V | Sewage Treatment Plant & Peconic River<br>*Heavy metal and radiological sediment and soil contamination, primarily mercury, silver, copper & cesium-137* | ♦ Finalized Plutonium Contamination Characterization and Radiological Dose and Risk Assessment Report.<br>♦ Finalized OU V Proposed Plan and held 90-day Public Comment Period.<br>♦ Presented proposed OU V remedy to interested community members at two Roundtable Meetings and a Public Meeting.<br>♦ Completed supplemental sampling of soil at Sewage Treatment Plant.<br>♦ Held two-day Peconic River Remedial Alternatives Workshop that was attended by more than 100 people. Sixteen vendors gave presentations in four sessions.<br>♦ Initiated development of conceptual engineering drawings of the Peconic River to help identify locations for additional sampling. |
| OU VI | Biology Fields<br>*Pesticide groundwater contamination-ethylenedibromide (EDB)* | ♦ Completed OU VI Contingency Remedy Evaluation.<br>♦ Continued monitoring of EDB plume.<br>♦ Released fact sheet/PRAP and conducted 30-day public comment period.<br>♦ Presented proposed OU VI remedy at a public meeting during the comment period. |
| Groundwater Monitoring | Ongoing Sitewide Project | ♦ Completed 1999 Sitewide Groundwater Monitoring Report.<br>♦ Completed BNL Groundwater Monitoring Program Quality Assurance Project Plan.<br>♦ Collected and analyzed over 2,180 groundwater samples from 18 monitoring programs. |
| Brookhaven Graphite Research Reactor (BGRR) Decommissioning | Radiologically contaminated water and fans<br>*primarily cesium-137.* | ♦ Completed removal of the Pile Fan Sump and surrounding soils.<br>♦ Released BGRR Removal Action Alternatives Study for public comment.<br>♦ DOE signed Action Memorandum approving the removal of the BGRR aboveground ducts as a time critical Removal Action.<br>♦ Removed fans from BGRR fan house. |

*New York - A Reference Handbook*. [BNL 1998a]). Table 2-7 provides a description of each OU (I-VII) and a summary of the environmental restoration actions taken during 2000 (see Figures 2-12a through f). Chapter 7 has a more detailed discussion of groundwater monitoring and restoration programs. A map of the OUs is found in Figure 2-13.

Significant progress was made in the BGRR Decommissioning Project and the High Flux Beam Reactor (HFBR) Project. The following activities were successfully completed at the BGRR in 2000:

- The Pile Fan Sump, associated piping, and contaminated soils were removed. The soil remediation indicated levels near background for the contaminants of concern, cesium-137 and strontium-90 (see Figure 2-12b).
- Removal of the aboveground ducts began in 2000 with the removal of the aboveground primary air cooling ducts over the Fan House (Bldg. 704) roof (see Figure 2-12a).
- The five primary air cooling fans were removed from their respective fan rooms in the Fan House.
- The graphite pile was fully characterized. The data obtained during characterization will be compiled, analyzed, and used to document the levels of contaminants identified in the pile.
- The graphite pile was sealed from Building 701. All openings on the biological shield wall of the graphite pile were sealed using various techniques and covers that permit surveillance and monitoring of the effectiveness of the seals.
- The Canal House (Bldg. 709), Water Treatment House (Bldg. 709A), equipment, and associated soils were characterized in accordance with an approved sampling and analysis plan to provide data for the preparation of the Engineering Evaluation and Cost Analysis.

With regard to the HFBR, on June 20, 2000, the EPA signed the OU III Record of Decision. In September, pumping of tritiated groundwater from the HFBR tritium plume was implemented along Temple Place. By the end of the year, 65,020 gallons (246,126 liters) of contaminated water had been removed from the highest activity areas of the HFBR tritium plume and disposed of offsite. During this process, numerous Geoprobes™ and monitoring wells were installed to maintain definition of the area of maximum concentration of the HFBR plume

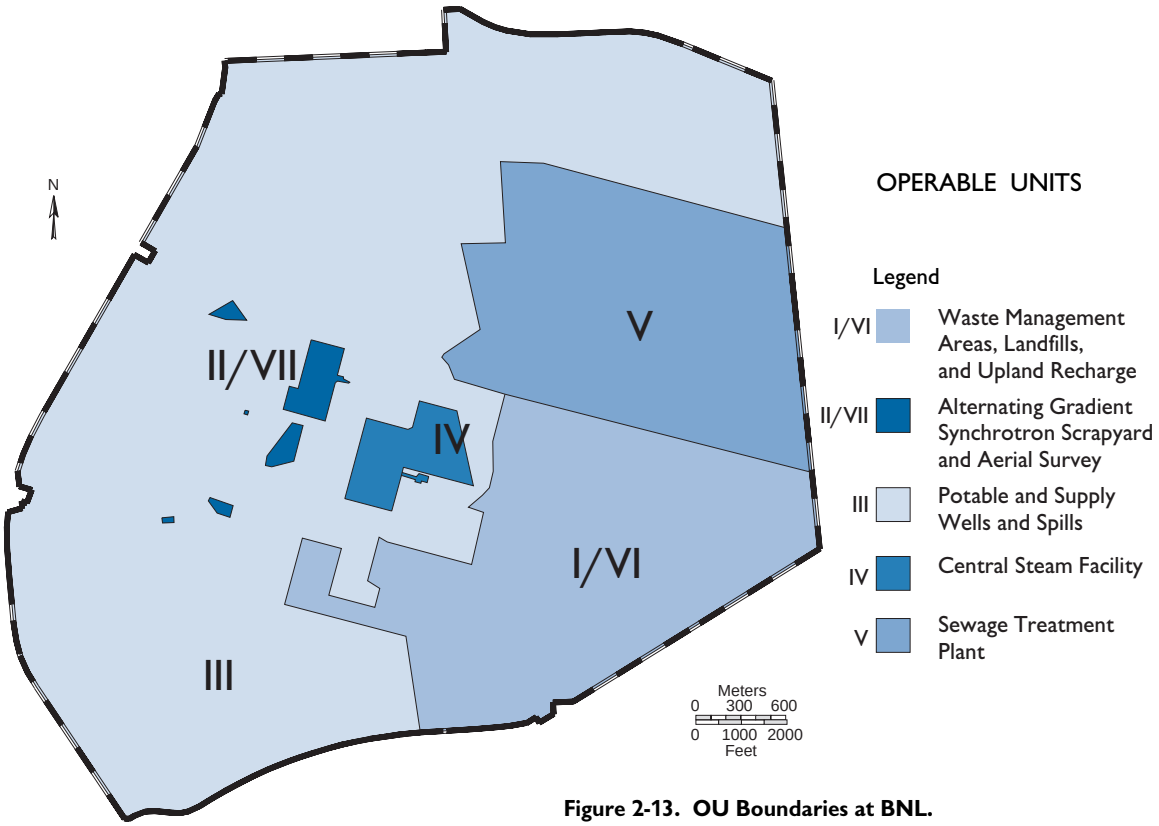


**Figure 2-13. OU Boundaries at BNL.**

and to guide the pumping initiative. In addition, routine groundwater monitoring continued to define the remainder of the plume.

#### 2.3.9.2 OPERABLE UNIT V – THE PECONIC RIVER

Operable Unit V received substantial attention during 2000. The Proposed Plan was issued for public comment in February. Two community information sessions, a public meeting and a workshop held in February and March were attended by more than 50 people (see Figure 2-12e).

In response to community requests, DOE extended the public comment period through May 15, 2000. Hundreds of comments were received during the comment period, most addressing the proposal to excavate contaminated sediment from the Peconic River. After considering comments and concerns expressed by community members and regulatory agencies, the Department decided to re-examine its plans to clean up the contaminated sediment.

On June 2, 2000, DOE mailed a letter to interested parties describing the planned path forward for OU V. In this letter, the Department committed to further consider sediment cleanup alternatives that would minimize disruption of wetlands, including an additional evaluation of phytoremediation. Phytoremediation is the use of plants to absorb contaminants from the sediments. DOE also pledged to offer additional opportunities for community involvement.

To fulfill these commitments, DOE sponsored a two-day workshop on remedial alternatives for the Peconic River in December 2000. At this workshop, which was attended by more than 100 people, 16 companies from across the nation made presentations. The presentations were grouped into sessions on phytoremediation, sediment removal, wetlands restoration/constructed wetlands, and other alternative technologies. Key stakeholders assisted in selecting presenters at a November 17, 2000 planning meeting and will comment on the workshop's results at a wrap-up meeting on January 2001. Workshop proceedings are available online at <http://web.ead.anl.gov/TechCon/projects/peconic/resources/index.cfm>.

### 2.3.10 COMMUNICATION AND COMMUNITY INVOLVEMENT

When BSA was awarded the contract to manage BNL in 1998, they made a commitment to establish an effective partnership between DOE, the Laboratory, and a full range of community members to address issues that affect quality of life in the community. At the core of the communication and community involvement programs are the Environmental Stewardship Policy and the Community Involvement Policy and Plan.

As discussed in Section 2.1.3, the Environmental Stewardship Policy contains a commitment to maintain a positive, proactive, and constructive relationship with the community and regulators, and to promote open communication on environmental performance. The Community Involvement Policy and Plan were written with input from both internal and external stakeholders, and document BSA's efforts to ensure the public will be kept informed of issues; that the Laboratory will actively seek and consider input from regulators, stakeholders, and the general public; and that opportunities will continue to be provided for an open, two-way exchange of information, knowledge, and perspectives.

The Laboratory continues efforts to improve working relationships with regulatory agencies by sharing information and working to resolve issues on plans, priorities, and corrective actions of importance to the regulators. The Laboratory meets regularly with regulators from the New York State Department of Environmental Conservation, the U.S. EPA Region II, and the Suffolk County Department of Health Services. Suffolk County inspectors have a permanent office onsite.

Another forum for communication is the Brookhaven Executive Roundtable, which was established by DOE in August 1997. The Roundtable is made up of representatives from elected officials and regulatory agencies. In addition, the Community Advisory Council was established in September 1998 to advise the Laboratory Director on issues of importance to their organizations. The Council consists of representatives from more than 30 varied stakeholder groups, including civic, business, union, health, education, employee, and environmental organizations. Both the Roundtable and the Council meet regularly, and are provided with frequent updates on Laboratory activities, environmental issues, and progress. Community representatives provide BNL with feedback and

recommendations that are considered in the Laboratory's decision-making processes. During 2000, numerous presentations with question and answer sessions were conducted at the Roundtable and Council meetings on topics such as the Groundwater Protection Program, groundwater monitoring results and corrective actions, the Groundwater Contingency Plan, the E-ALARA program, the Upton Ecological and Research Reserve, the EMS, the Landtrek Project, and the 1999 Site Environmental Report.

Stakeholders are provided with many other opportunities to learn about and provide input on issues of importance to them—from working groups to roundtables to one-on-one interactions with managers and subject matter experts. Input is actively sought to help the Laboratory make better decisions that take the community's values and perspectives into account. Public outreach activities include briefings to local civic and community groups; meetings and presentations to local, state, and federal regulators and elected officials; and regular interactions with the business and educational community. Laboratory Envoys, who are well educated about BNL and its issues, regularly interact within individuals and groups in the community, gathering feedback, and responding to concerns. In 2000, the Laboratory hosted over 35,000 visitors, including students and community members who participated in the Summer Sunday tour program and an Environmental Fair held in the fall. The Laboratory also has an informative website <www.bnl.gov>, issues press releases, publishes the *Brookhaven Bulletin* (a weekly employee newsletter), *cleanupdate* (a periodic newsletter on environmental cleanup), *Laboratory Link* (a monthly brief on research and environmental issues for community members), and issues e-mail updates to inform the public and staff about environmental issues. Section 6.8 in Chapter 6 discusses additional outreach activities associated with the natural resource program.

In 2000, BNL celebrated the 30th anniversary of Earth Day with a variety of activities involving BNL staff and the community, including environmental awards, an art contest, a race, onsite birding field trips and displays. (See Figure 2-14.) BSA contributed corporate funds in support of events as part of their commitment to environmental stewardship. Many community organizations also helped sponsor the activities and awards.

Another innovative program that BNL worked on in 2000 is the Landtrek project, which is an extension of the BNL Environmental Information Management System. The BNL Landtrek project, developed with support from DOE headquarters, provides environmental monitoring data to the public and BNL staff and managers over the Internet. Community and staff input were solicited to determine the level of interest in this data and how it should be presented. Based on this input, a developmental website was released that included an overview of BNL's monitoring activities and current groundwater monitoring data for two BNL facilities (the Brookhaven Linac Isotope Producer and the Brookhaven Medical Research Reactor). The database is found at <http://www.landtrek.org/LandTrek/Projects/bnl/bnl/>. Information on the project can also be found at <http://www.bnl.gov/esd/landtrek.htm>. BNL plans to expand the Landtrek website in the future by providing additional data on other BNL facilities and environmental media.

### 2.4 ENVIRONMENTAL STEWARDSHIP AT BNL TODAY

In 2000, BNL invested more than $26 million in the environmental management system, pollution prevention, groundwater protection, environmental restoration programs, and information management systems designed to improve the Laboratory's environmental systems and performance. These systems and programs are a high priority for BNL, which takes its commitment to be a good neighbor and a responsible steward of the environment very seriously.

BNL now has an unprecedented knowledge of potential environmental vulnerabilities and current operations. Compliance assurance programs are improving BNL's compliance status. Pollution prevention projects have reduced costs 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. BNL must continue to deliver on commitments and demonstrate real improvements in environmental performance in order to regain the stakeholders' trust. This annual Site Environmental Report is an important communication mechanism, as it summarizes BNL's environ-

**a.** Environmental awards were presented to two BNL employees, a middle manager and senior manager (Dr. Satoshi Ozaki, shown here with Dr. Marburger) who have championed environmental protection at BNL, and went above and beyond their jobs to promote pollution prevention.

**b.** Environmental awards were presented to Suffolk County/East End students from the 3rd - 5th grades whose artwork was selected for publication in the 1999 Site Environmental Report. Over 250 students submitted entries. Artwork by Ariel Grant (shown here) was featured on the cover of the 1999 report.

**c.** The Earth Week celebration culminated with a four-mile race through the Pine Barrens onsite. Over 130 runners participated.

**d.** Environmental Services Division employees package 157 pounds of food, donated to the Long Island Cares Food Bank as part of the runners' entry fee.

**Figure 2-14. Earth Week 2000 Events at BNL.**

mental programs and performance for the 2000 calendar year. Additional information about BNL's environmental programs is available on BNL's website at <www.bnl.gov>. Environmental project plans, status reports, procedures, and more are accessible to the general public on the Internet at <http://www.bnl.gov/esd/>. The Laboratory is pursuing other mechanisms to communicate data in a more user friendly, visual, and timely manner, such as the BNL Landtrek project, which is viewed as a model in the DOE complex.

BNL's EMS includes a commitment to continual improvement. The Laboratory fulfills

this commitment by establishing performance goals, developing action plans to achieve these goals, and periodic assessing performance. These processes are implemented within the context of the broader, Labwide efforts to improve the management systems. Although only one or two cycles of implementation have occurred within most organizations at BNL, improvements to the EMS have already been possible due to the pilot facility implementation. Lessons learned, tools, and procedures developed by these first organizations were incorporated into the base program and made available to the balance of facilities.

The existing BNL EMS is viewed as exemplary in the DOE complex. In a letter to the DOE-Brookhaven Area Office, the manager of DOE-Chicago cited the EMS as a noteworthy example for consideration by other DOE facilities, and said he was very pleased by the Laboratory's demonstrated commitment to environmental management (San Martin 2000). Nine BNL facilities have been registered to the ISO 14001 standard. BNL is still the only DOE National Laboratory that has achieved ISO 14001 registration. Due to external recognition of BNL's knowledge and unique experience implementing the ISO 14001 EMS program, several DOE facilities and private universities invited BNL to extend its outreach activities and share its experiences, lessons learned, and successes. As noted above, BNL's environmental programs and projects have been recognized with regional and national awards.

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

- The EMS, which was built on an existing foundation, has been strengthened, integrated with other BNL management systems, and formalized. BNL has looked at everything in a more systematic way.
- There is now line ownership for environmental stewardship, key roles and responsibilities have been identified/clarified, and expectations have been clarified.
- A comprehensive environmental training program has been established.
- Organizations have an improved understanding of environmental aspects, waste streams, and applicable requirements from the process evaluations.
- 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 registration, compliance improvements (e.g., facility modifications, implementation of SBMS, enhanced operational controls), and increased environmental knowledge and awareness on the part of management, employees, and visiting scientists.
- Communications on environmental issues have improved, occur at the highest levels of management, and reporting is more formal. Managers are better informed about aspects, issues, and performance.
- Core EMS teams cutting across organizations have been formed, and the consensus process used to develop the system has improved buy-in.
- There has been strong penetration of the EMS throughout organizations, and cultural change has been sweeping.

For 50 years, the unique, leading-edge facilities at BNL have made many innovative scientific contributions possible. Today, BNL continues its research mission while paying much closer attention to 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." This reflects BNL's desire to balance world-class research with environmentally responsible operations.

EXPLORING EARTH'S MYSTERIES
...PROTECTING ITS FUTURE

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Chapter 3

# Compliance Status

Brookhaven National Laboratory is subject to more than 50 sets of federal, state, and local environmental regulations; 65 site-specific permits; and several other binding agreements. In 2000, BNL operated in compliance with the majority of these requirements, and programs are in place to address areas for continued improvement.

Emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide were all within permit limits. Approximately 3,300 pounds (1,500 kg) of ozone-depleting refrigerants were recovered for recycling. Monitoring of the BNL potable water system showed that the potable water supply met all regulatory requirements. Groundwater monitoring at the Major Petroleum Facility continues to demonstrate that current oil storage and transfer operations are not impacting groundwater quality. During 2000, liquid effluents discharged to surface water and groundwater met all New York State Pollutant Discharge Elimination System permit requirements with the exception of 11 excursions: 8 at the Sewage Treatment Plant and 3 at other outfalls. All permit excursions were reported to the New York State Department of Environmental Conservation (NYSDEC).

Fourteen reportable spills of petroleum products occurred onsite in 2000. The majority were less than ten gallons, and all were cleaned up or addressed to the satisfaction of the NYSDEC. In addition to petroleum spills, two other hazardous substances were released in amounts that required reporting to the appropriate regulatory agencies. These were a 5-gallon (18.9 liters) release of spent photographic developer and a leak of 8 pounds (3.6 kg) of mercury. Both spills were cleaned up immediately.

BNL underwent 13 environmental audits by external regulatory agencies in 2000. These included review of petroleum storage, hazardous waste operations, air emissions from the Central Steam Facility, and inspections of the Sewage Treatment Plant, outfalls/recharge basins, and potable water system. The NYSDEC hazardous waste inspection resulted in issuance of a Notice of Violation. Immediate corrective actions were taken to address all concerns. The Major Petroleum Facility was found to be in substantial compliance with the license; however, several minor issues were identified. Corrective actions were implemented to address these issues.

## 3.1 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

Brookhaven National Laboratory is subject to more than 50 sets of federal, state, and local environmental regulations; 65 site-specific permits; 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.

## 3.2 ENVIRONMENTAL PERMITS

### 3.2.1 EXISTING PERMITS

Many processes and facilities at BNL operate under permits issued by environmental regulatory agencies. These permits include:

- State Pollutant Discharge Elimination System (SPDES) permit,
- Major Petroleum Facility (MPF) License,
- Resource Conservation and Recovery Act (RCRA) permit for the Waste Management Facility,
- Registration certificate from the New York State Department of Environmental Conservation (NYSDEC) for tanks storing bulk quantities of hazardous substances,
- NYSDEC certificates for two registered gasoline vapor recovery systems,
- Seven radiological emission authorizations issued under the National Emission Standards for Hazardous Air Pollutants (NESHAPs) by the U.S. Environmental Protection Agency (EPA),
- Forty-seven Certificates to Operate air emission sources from the NYSDEC,
- One NYSDEC NESHAPs permit for asbestos emissions from the Inhalation Toxicology Facility,
- Two permits for construction activities within the Peconic River corridor,
- An Underground Injection Control (UIC) Area permit for the operation of 90 wells,
- A permit for the operation of six domestic water supply wells.

Table 3-2 provides a complete listing of these permits. In addition to those listed, the operation of six groundwater pump and treat systems installed under the Interagency Agreement (Federal Facility Agreement under CERCLA 120, Admin Docket No. II-CERCLA-FFA-00201) is authorized under SPDES and air emission equivalency permits.

In addition to the operating permits, permits are periodically acquired for construction activities. These include well-point dewatering, freshwater wetland, and Wild, Scenic, and Recreational River System Act permits. In 2000, two permit applications were filed with the NYSDEC for work at the Relativistic Heavy Ion Collider (RHIC) facility. The projects included construction of a security fence around the perimeter of the RHIC and the extension of sanitary sewers to the RHIC facilities. Since both projects required crossing the Peconic River, freshwater wetlands, and Wild, Scenic, and Recreational River System Act permits were required.

### 3.2.2 NEW OR MODIFIED PERMITS, OR PERMIT MODIFICATION REQUESTS

#### 3.2.2.1 STATE POLLUTANT DISCHARGE ELIMINATION SYSTEM (SPDES)

The SPDES permit authorizes discharges from the BNL Sewage Treatment Plant (STP) to the Peconic River, and discharges of cooling and stormwater to recharge basins including those from the RHIC facilities. In November, the Laboratory submitted a request to change the cooling tower corrosion prevention additives. In accordance with the conditions of the permit, all corrosion control chemicals must be reviewed and approved by the NYSDEC. While it is believed that the proposed chemicals are more environmentally benign than existing products, the NYSDEC requested additional information regarding these additives. This review is still pending.

#### 3.2.2.2 AIR

*Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).* During 2000, BNL maintained two state air equivalency permits for environmental restoration projects conducted under CERCLA. These are:

- Operable Unit (OU) I: In December 1998, NYSDEC issued an equivalency permit for the operation of a high vacuum thermal desorption unit. The unit was approved for processing mercury-contaminated mixed soil waste recovered from the OU I Chemical Holes area. It was used from January through mid-summer 2000, at which time all of the waste had been processed.

**Table 3-1. Federal, State, and Local Environmental Statutes and Regulations Applicable to BNL (CY 2000).**

| Regulator: Codified Regulation | Regulatory Program Description | Compliance Status | Report Reference Sections |
|---|---|---|---|
| EPA:<br>40 CFR 300<br>40 CFR 302<br>40 CFR 355<br>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 between EPA, NYSDEC, and DOE. Remediation of the BNL site is conducted by the Environmental Restoration Program in accordance with milestones established under this agreement. | 2.3.9 |
| Council for Env. Quality:<br>40 CFR 1500 - 1508<br>DOE:<br>10 CFR 1021 | The **National Environmental Policy Act** (NEPA) requires federal agencies to follow a prescribed process to evaluate 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 the NEPA requirements. The Laboratory has established sitewide procedures for the implementation of NEPA requirements. | 3.3 |
| Advisory Council on Historic Preservation:<br>36 CFR 60<br>36 CFR 63<br>36 CFR 79<br>36 CFR 800<br>43 CFR 7 | The **National Historic Preservation Act** identifies, evaluates, and protects historic properties eligible for listing in the National Register of Historic Places. Historic properties can be archeological sites, historic structures, or historic document records or objects. | The Brookhaven Graphite Research Reactor (BGRR) complex and World War I trenches in the area of the Relativistic Heavy Ion Collider project have been determined to be eligible for inclusion in the National Register of Historic Places. The former Cosmotron building was identified as being potentially eligible in an April 1991 letter from the New York State Historic Preservation Officer (NYSHPO). Any activities involving these facilities are identified through the NEPA process and an evaluation is initiated to determine if the proposed action would impact the features that extend eligibility to these facilities. Some activities associated with the Decontamination and Decommissioning of the BGRR were determined to impact its eligibility, and mitigative actions are proceeding according to a Memorandum of Agreement between DOE and the NYSHPO. BNL is currently developing a Cultural Resource Management Plan to ensure compliance with applicable cultural resource regulations. | 3.4 |
| EPA:<br>40 CFR 50 – 80<br>40 CFR 82<br>NYSDEC:<br>6 NYCRR 200 –258<br>6 NYCRR 307 | The **Clean Air Act** (CAA) and the New York State Environmental Conservation Laws regulate the release of air pollutants through the use of permits and air quality limits. Emissions of radionuclides are regulated by the EPA, under **National Emission Standards for Hazardous Air Pollutants** (NESHAPs) authorizations. | All air emission sources have permits or have been exempted under the New York State air program. | 3.5 |
| EPA:<br>40 CFR 109 –140<br>40 CFR 230 – 231<br>40 CFR 401<br>40 CFR 403<br>NYSDEC:<br>6 NYCRR 700 –703<br>6 NYCRR 750 –758 | The **Clean Water Act** (CWA) and corresponding New York State Environmental Conservation Laws seek to improve the quality of surface waters by implementing a permitting program and establishing water quality standards. Wastewater discharges are permitted by NYSDEC. | Permitted discharges include treated sanitary waste, and cooling tower and storm water discharges. With the exception of eleven excursions, these discharges met the State Pollutant Discharge Elimination System permit limits in 2000. | 3.6 |
| EPA:<br>40 CFR 141 – 149<br>NYSDOH:<br>10 NYCRR 5 | The **Safe Drinking Water Act** (SDWA) and New York State Department of Health standards for public water supplies establish minimum drinking water standards and monitoring requirements. Safe Drinking Water Act requirements are enforced by the Suffolk County Department of Health Services. | BNL maintains a sitewide public water supply. This water supply meets all primary and secondary drinking water standards as well as operational and maintenance requirements. | 3.7 |
| EPA:<br>40 CFR 112<br>40 CFR 328<br>40 CFR 355<br>40 CFR 370<br>40 CFR 372 | The **Oil Pollution Act**, **Emergency Planning and Community Right-to-Know Act** (EPCRA), and the **Superfund Amendment Reauthorization Act** (SARA) require that facilities storing large quantities of petroleum products and/or chemicals prepare emergency planning documents and report the inventory of such chemicals to the EPA, State and Local emergency planning groups. | Since facilities at BNL store or use chemicals or petroleum in quantities exceeding threshold planning quantities, BNL is subject to these requirements. BNL is in full compliance with all emergency planning requirements. | 3.8.1<br>3.8.2 |

*(continued on next page)*

**Table 3-1. Federal, State, and Local Environmental Statutes and Regulations Applicable to BNL (CY 2000)** *(concluded)*.

| Regulator: Codified Regulation | Regulatory Program Description | Compliance Status | Report Reference Sections |
|---|---|---|---|
| EPA:<br>40 CFR 280<br>NYSDEC:<br>6 NYCRR 595 – 597<br>6 NYCRR 611 – 613<br>SCDHS:<br>SCSC Article 12 | Federal, state, and local regulations regulate the storage of chemicals and petroleum products to prevent releases of these materials to the environment. | BNL is subject to a vast set of regulations governing storage of chemicals, petroleum products, and wastes. 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 is working towards achieving full conformance to county codes. | 3.8.4<br>3.8.5<br>3.8.6 |
| EPA:<br>40 CFR 260 – 280<br>NYSDEC:<br>6 NYCRR 360 - 374 | 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, audits identified several concerns. These were immediately addressed by corrective actions. | 3.9 |
| EPA:<br>40 CFR 700 – 766 | 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:<br>40 CFR 162 –171<br>NYSDEC:<br>6NYCRR 320 – 329 | The **Federal Insecticide, Fungicide, and Rodenticide Act** (FIFRA) and corresponding New York State regulations govern the manufacture, use, storage, and disposal of pesticides and herbicides, as well as pesticide containers and residuals. | BNL employs New York State-certified pesticide applicators for the application of pesticides and herbicides on the site. Each applicator attends training as needed to maintain all certifications current. Annual reports detailing the types and quantity of pesticides applied are filed by each applicator each year by February 1st. | 3.11 |
| DOE:<br>10 CFR 1022<br>NYSDEC:<br>6NYCRR 662<br>6 NYCRR 663<br>6 NYCRR 666 | DOE regulations govern compliance with floodplain/ wetland review requirements. The **New York State Fresh Water Wetlands** and **Wild, Scenic, and Recreational Rivers** regulations govern development in natural water ways. Development or projects occurring within ½ mile of regulated waters are subject to permitting by the NYSDEC. | The BNL is located within the Peconic River watershed and has several jurisdictional wetlands; consequently development of locations in the north and east are subject to permitting by the NYSDEC and review for compliance under DOE wetland/floodplain regulations. During 2000, two projects were permitted under New York State programs. | 3.12 |
| U.S. Fish and Wildlife Service:<br>50 CFR 11<br>NYSDEC:<br>6 NYCRR 182 | The **Endangered Species Act** and corresponding New York State regulation prohibit activities that would jeopardize the continued existence of an endangered or threatened species, or cause adverse modification to a critical habitat. | One New York State endangered species (the tiger salamander), three threatened (the banded sunfish, the swamp darter, and the stiff goldenrod), and eight species of special concern have been identified onsite. The Laboratory has prepared a Wildlife Resource Management Plan that outlines activities to protect species and enhance their habitats. | 3.13 |

Notes:
CFR = U.S. Code of Federal Regulations
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
NYCRR = New York Codes, Rules, and Regulations
NYSDEC = New York State Department of Environmental Conservation
NYSDOH = New York State Department of Health
SCDHS = Suffolk County Department of Health Services
SCSC = Suffolk County Sanitary Code

- Operable Unit (OU) III: In November 2000, an equivalency permit application was submitted to the NYSDEC for a newly constructed in-well air stripping treatment system designed to remediate groundwater contaminated with volatile organic compounds in OU III. The application was prepared to demonstrate that anticipated airborne emissions associated with the system are properly controlled in conformance with 6 NYCRR 212 air pollution control requirements. The treatment system did not operate in 2000.

*Clean Air Act Title V.* Under the Clean Air Act (CAA), BNL is defined as a major source of criteria pollutant ($NO_x$, $SO_x$) emissions and is required to obtain a Title V operating permit. This permit will consolidate all emission sources and all applicable federal and state regulatory requirements into a single

**Table 3-2. BNL Environmental Permits (CY 2000).**

| Building or Facility | Process/Equipment Designation Description | Permitting Agency and Division | Permit Number | Expiration Date |
|---|---|---|---|---|
| 197 | welding shop | NYSDEC-Air Quality | 1-472200 3491 19704 | 04-01-00[a] |
| 197 | epoxy coating/curing exhaust | NYSDEC-Air Quality | 1-472200 3491 19708 | 06-08-98[a] |
| 206 | cyclone G-10 | NYSDEC-Air Quality | 1-472200 3491 20601 | 04-01-00[a] |
| 207 | belt sander | NYSDEC-Air Quality | 1-472200 3491 20701 | 04-01-00[a] |
| 244 | cyclone collector | NYSDEC-Air Quality | 1-472200 3491 24401 | 01-28-99[a] |
| 422 | cyclone collector | NYSDEC-Air Quality | 1-472200 3491 42202 | 11-29-96 [a] |
| 422 | cyclone collector | NYSDEC-Air Quality | 1-472200 3491 42203 | 11-29-96 [a] |
| 423 | stage II vapor recovery | NYSDEC-Air Quality | 1-472200 D365 WG | None [b] |
| 423 | welding hood | NYSDEC-Air Quality | 1-472200 3491 42305 | 05-15-01 |
| 458 | paint spray booth | NYSDEC-Air Quality | 1-472200 3491 45801 | 04-23-97[a] |
| 462 | machining, grinding exhaust | NYSDEC-Air Quality | 1-472200 3491 46201 | 11-29-96[a] |
| 462 | machining, grinding exhaust | NYSDEC-Air Quality | 1-472200 3491 46202 | 11-29-96[a] |
| 473 | vapor degreaser & fume hood | NYSDEC-Air Quality | 1-472200 3491 47301 | 03-22-96[c] |
| 479 | cyclone G-10 | NYSDEC-Air Quality | 1-472200 3491 47905 | 04-01-00[a] |
| 490 | Inhalation Toxicology Facility | NYSDEC-NESHAPs | 1-472200 3491 49001 | 05-15-01 |
| 490 | Inhalation Toxicology Facility | NYSDEC-Air Quality | 1-472200 3491 49002 | 05-15-01[d] |
| 490 | lead alloy melting | NYSDEC-Air Quality | 1-472200 3491 49003 | 05-15-01 |
| 490 | milling machine/block cutter | NYSDEC-Air Quality | 1-472200 3491 49004 | 05-15-01 |
| 510 | metal cutting exhaust | NYSDEC-Air Quality | 1-472200 3491 51002 | 09-30-98[a] |
| 510 | calorimeter enclosure | EPA - NESHAPs | BNL-689-01 | None |
| 526 | polymer mix booth | NYSDEC-Air Quality | 1-472200 3491 52601 | 04-01-00[a] |
| 526 | polymer weighing | NYSDEC-Air Quality | 1-472200 3491 52602 | 04-01-00[a] |
| 535B | plating tank | NYSDEC-Air Quality | 1-472200 3491 53501 | 04-01-00[a] |
| 535B | etching machine | NYSDEC-Air Quality | 1-472200 3491 53502 | 04-01-00[a] |
| 535B | PC board process | NYSDEC-Air Quality | 1-472200 3491 53503 | 05-15-01 |
| 535B | welding hood | NYSDEC-Air Quality | 1-472200 3491 53504 | 09-30-98[a] |
| 555 | scrubber | NYSDEC-Air Quality | 1-472200 3491 55501 | 04-01-00[d] |
| 555 | scrubber | NYSDEC-Air Quality | 1-472200 3491 55502 | 04-01-00[d] |
| 610 | combustion unit | NYSDEC-Air Quality | 1-472200 3491 6101A | 05-15-01 |
| 610 | combustion unit | NYSDEC-Air Quality | 1-472200 3491 61005 | 05-15-01 |
| 610 | combustion unit | NYSDEC-Air Quality | 1-472200 3491 61006 | 05-15-01 |
| 610 | combustion unit | NYSDEC-Air Quality | 1-472200 3491 61007 | 12-18-02 |
| 630 | stage II vapor recovery | NYSDEC-Air Quality | 1-472200 D366 WG | None[b] |
| 703 | machining exhaust | NYSDEC-Air Quality | 1-472200 3491 70301 | 05-15-01 |
| 705 | building ventilation | EPA – NESHAPs | BNL-288-01 | None |
| 820 | accelerator test facility | EPA – NESHAPs | BNL-589-01 | None |
| 865 | lead melting pot | NYSDEC Air Quality | 472200 3491 86501 | 01-14-03 |
| 902 | spray booth exhaust | NYSDEC-Air Quality | 472200 3491 90201 | 09-30-98[a] |
| 902 | belt sander | NYSDEC-Air Quality | 472200 3491 90202 | 05-15-01 |
| 902 | sanding, cutting, drilling | NYSDEC-Air Quality | 472200 3491 90203 | 05-15-01 |
| 902 | brazing/soldering exhaust | NYSDEC-Air Quality | 472200 3491 90204 | 05-15-01 |
| 902 | painting/soldering exhaust | NYSDEC-Air Quality | 472200 3491 90205 | 05-15-01 |
| 903 | cyclone G-10 | NYSDEC-Air Quality | 472200 3491 90302 | 04-01-00[a] |
| 903 | brazing process exhaust | NYSDEC-Air Quality | 472200 3491 90303 | 09-30-98 [a] |
| 905 | machining exhaust | NYSDEC-Air Quality | 472200 3491 90503 | 05-15-01 |
| 919A | solder exhaust | NYSDEC-Air Quality | 472200 3491 91903 | 05-15-01 |
| 922 | cyclone exhaust | NYSDEC-Air Quality | 472200 3491 92201 | 04-01-00[a] |
| 923 | electronic equipment cleaning | NYSDEC-Air Quality | submitted 3-93 | status pending[e] |
| 924 | spray booth exhaust | NYSDEC-Air Quality | 472200 3491 92401 | 09-30-98[f] |
| 924 | magnet coil production press | NYSDEC-Air Quality | 472200 3491 92402 | 05-15-01 |
| 924 | machining exhaust | NYSDEC-Air Quality | 472200 3491 92403 | 05-03-98[a] |
| 930 | electroplating/acid etching | NYSDEC-Air Quality | 472200 3491 93001 | 05-15-01[f] |
| 930 | bead blaster | NYSDEC-Air Quality | 472200 3491 93002 | 05-15-01 |
| AGS Booster | accelerator | EPA - NESHAPs | BNL-188-01 | None |
| RHIC | accelerator | EPA - NESHAPs | BNL-389-01 | None |

*(continued on next page)*

**Table 3-2. BNL Environmental Permits (CY 2000)** *(concluded)*.

| Building or Facility | Process/Equipment Designation Description | Permitting Agency and Division | Permit Number | Expiration Date |
|---|---|---|---|---|
| RTF | | EPA - NESHAPs | BNL-489-01 | None |
| REF/NFB | | EPA - NESHAPs | BNL-789-01 | None |
| CSF | major petroleum facility | NYSDEC-Water Quality | 1-1700 | 03-31-02 |
| SPDES | sewage plant & Other Outfalls | NYSDEC-Water Quality | NY-0005835 | 03-01-05 |
| WMF | waste management | NYSDEC - Hazardous Waste | 1-4722-00032/00102-0 | 07-12-05 |
| BNL Site | chemical tanks- HSBSRC | NYSDEC - Bulk Storage | 1-000263 | 7-27-01 |
| BNL Site | Underground Injection Controls | EPA - Safe | NYU500001 | 02-11-11 |
| RHIC | Security Fence | NYSDEC - Nat. Res. | 1-4722-0032/00117 | 04-10-03 |
| RHIC | Sewer Extension | NYSDEC - Nat. Res. | 1-4722-0032/00123 | 07/31/04 |
| Plant Engineering | Potable Water Wells | NYSDEC - Nat. Res. | 1-4722-00032\00113-0 | 09/13/08 |

Notes:
AGS = Alternating Gradient Synchrotron
CSF = Central Steam Facility
EPA = U.S. Environmental Protection Agency
HSBSRC = Hazardous Substance Bulk Storage Registration Certificate
NESHAPs = National Emission Standards for Hazardous Air Pollutants
NYSDEC = New York State Department of Environmental Conservation
REF/NFB = Radiation Effects Facility/Neutral Beam Facility
RHIC = Relativistic Heavy Ion Collider
RTF = Radiation Therapy Facility
STP & RCB = Sewage Treatment Plant and Recharge Basins
WMF = (New) Waste Management Facility

(a) Permits for processes with past due expiration dates have been extended until NYSDEC approves BNL's Title V permit or until the NYSDEC reclassifies the processes as exempt and trivial pursuant to 6 NYCRR Part 201 provisions.
(b) NYSDEC has indicated the process is subject to registration only.
(c) The vapor/sonic degreaser and fume hood shared a common exhaust stack. The degreaser has been removed. The fume hood is still used for aerosol spray coating and wipe cleaning of parts.
(d) Process is not in service.
(e) Response to application never received from the NYSDEC. The process was also included in the BNL Title V permit application.
(f) Process removed from service.

document. The permit application was originally filed in December 1998. After completing an initial quality assurance review of the application, NYSDEC forwarded an Administrative Error Report to BNL in June 1999. The report identified administrative errors that BNL needed to address before the application could be considered complete. The administrative errors in the BNL application were corrected and some minor revisions were made to the application to capture emission sources that were identified during the Process Evaluation Project (see Chapter 2, Section 2.2.2 for a description of this project). An amended permit application was submitted to the NYSDEC in February 2000. Staff from the NYSDEC have examined the revised application and indicated that they expect to issue a draft Title V permit to BNL by the end of June 2001.

#### 3.2.2.3 UNDERGROUND INJECTION CONTROL (UIC)

Under the Safe Drinking Water Act, BNL was required to apply for and obtain an Area Permit for underground injection control wells (e.g., drywells, cesspools, leaching pools). The application required the submittal of an Area permit application, a complete inventory of all UICs, and a map depicting the location of each of the UICs. An application was initially filed in December 1998 and revised in September 1999. The application was approved in August 2000 with the issuance of a draft permit. A final permit was issued in January 2001. This permit authorizes the operation of 90 UICs, including 86 stormwater drywells and 4 small sanitary systems.

### 3.3 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

NEPA regulations require federal agencies to follow a prescribed process to evaluate the impacts of proposed major federal activities on the environment. This process ensures that the proper level of environmental review is performed before an irreversible commitment of resources is made. During 2000, environmental evaluations were completed for 89 proposed projects. Of these, 71 were considered minor actions requiring no additional documentation. The remaining 18 projects were addressed through submission of Environmental Evaluation Notification Forms to the U.S. Department of Energy (DOE), all resulted in the determination that they were covered by existing Categorical Exclusions as defined by 10 CFR 1021.

Preparation of an Environmental Assessment to evaluate proposed upgrades to the National Synchrotron Light Source, Accelerator Test Facility, and the Source Development Lab continued in 2000.

### 3.4 NATIONAL HISTORIC PRESERVATION ACT AND ARCHAEOLOGICAL RESOURCE PROTECTION ACT

BNL is subject to several cultural resource laws, most notably the National Historic Preservation Act and the Archeological Resource Protection Act. 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 Native American Indian lands.

The Laboratory currently has three structures or sites that have been determined to be either eligible for listing (the Brookhaven Graphite Research Reactor [BGRR] complex and the World War I training trenches associated with Camp Upton), or may be eligible (the Cosmotron). In January 2000 the New York State Historic Preservation Officer concurred with BNL's determination that WW II era Building 577, located at the Sewage Treatment Plant, was not eligible for listing on the National Register of Historic Places.

During 2000, activities associated with cultural resource management included the following:

- A contract was issued to perform an architectural inventory of BNL buildings and structures in order to identify and evaluate properties for their historic value. The field survey of approximately 440 BNL structures has been completed.
- The location of additional networks of WW I training trenches were identified in 2000. The Laboratory also researched holdings related to Camp Upton at both the Suffolk County Historical Society and the Longwood Public Library.
- A Memorandum of Agreement (MOA) for the Mitigation of the Decommissioning of the BGRR (Desmarais 2000) was approved and signed. BNL began developing the mitigation packages associated with the BGRR MOA, including initiating production of a BGRR history video documentary and contracting the services of a professional archivist to start development of a BGRR Researcher's Guide.
- The concept for a Camp Upton Historic Museum Complex was described in the *BNL Site Master Plan* issued in 2000 (BNL 2000). The museum complex was also designated as an official project of *Save America's Treasures,* which is a White House Millennium Council initiative partnered with the National Trust for Historic Preservation (Green 2000).
- Completion of the annual Department of Interior questionnaire regarding historic/cultural resources.

Additionally in 2000, a project work plan for the development of a Cultural Resources Management Plan was submitted to the DOE Brookhaven Area Office for review. A Cultural Resource Management Plan will provide standards for BNL to efficiently manage historic structures/objects located on BNL property (see Chapter 6, Section 6.9 for additional information).

### 3.5 CLEAN AIR ACT (CAA)

The objectives of the CAA (administered by the EPA and NYSDEC) are to improve or maintain regional ambient air quality through operational and engineering controls on stationary or mobile sources of air pollution. Both conventional and hazardous air pollutants are regulated under the CAA.

#### 3.5.1 CONVENTIONAL AIR POLLUTANTS

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

##### 3.5.1.1 REASONABLE AVAILABLE CONTROL TECHNOLOGY (RACT)

BNL has four boilers (Nos. 1A, 5, 6, and 7) located at the Central Steam Facility that are subject to NYSDEC RACT requirements. All boilers, except for 1A, are bi-fuel and can burn either residual fuel oil or natural gas. Natural gas was the predominant fuel burned in Boiler 6, while Boilers 5 and 7 burned mostly low nitrogen and sulfur content residual fuel oil.

RACT requirements establish emission standards for oxides of nitrogen ($NO_x$) for boilers with maximum operating heat inputs greater than or equal to 50 MMBtu/hr (14.6 MW). Compliance requirements are based upon the size of the boilers. Boilers with a maximum operating heat input between 50 and 250 MMBtu/hr (14.6 and 73.2 MW) can demonstrate compliance using periodic emissions tests or by using continuous emission monitoring equipment. Emission tests conducted in 1995 confirmed that BNL Boilers 1A and 5, both of which have maximum operating heat inputs less than 250 MMBtu/hr (73.2 MW), met the $NO_x$ emission standards when burning low nitrogen and sulfur content residual fuel oil (below 0.3%). To ensure continued compliance, an outside contractor laboratory analyzed composite samples of fuel deliveries (collected quarterly) and confirmed that the fuel-bound nitrogen and sulfur content met these requirements. Compliance with the 0.30 lbs/MMBtu (130 ng/J) $NO_x$ emissions standards for Boilers 6 and 7 was demonstrated by continuous emission monitoring of the flue gas. For the year 2000, $NO_x$ emissions from Boilers 6 and 7 averaged 0.120 lbs/MMBtu (52 ng/J) and 0.232 lbs/MMBtu (101 ng/J), respectively, and there were no recorded exceedances of the $NO_x$ emissions standard for either boiler.

#### 3.5.1.2 OZONE DEPLETING SUBSTANCES

All refrigerant recovery and recycling equipment used by refrigerant service technicians is certified to meet refrigerant evacuation levels specified by 40 CFR 82.158. Under the preventative maintenance program, refrigeration and air conditioning equipment containing ozone-depleting substances is regularly inspected and maintained. As a matter of standard practice, if a refrigerant leak is found, technicians will either immediately repair the leak, or isolate the leak and prepare a work order for the needed repairs. This practice exceeds the leak repair provisions of 40 CFR 82.156.

Approximately 1,710 pounds (776 kg) of R-11, 12 pounds (5 kg) of R-12, and 434 pounds (197 kg) of R-22 refrigerants were recovered and reclaimed for future use from equipment that was serviced during 2000. More than 1,160 pounds (526 kg) of R-11 were recovered and sent out for reclamation when a 165-ton (149.7 metric tons) and a 350-ton (317.5 metric tons) centrifugal chiller were dismantled and replaced with new 320-ton (290.3 metric tons) and 450-ton (408.2 metric tons) R-123 chiller units, respectively.

#### 3.5.1.3 HALON

Halon 1211 and 1301 are extremely efficient fire suppressants but are no longer acceptable extinguishing media due to their impact on the earth's ozone layer. In 1998 BNL purchased recovery/recycling equipment to comply with the halon recovery and recycling requirements of the CAA, 40 CFR 82 Subpart H. Halon recovery/recycling devices are used when portable fire extinguishers or fixed systems are removed from service and during periodic hydrostatic testing of halon cylinders. In 2000, the device was used to recover Halon 1211 from one portable fire extinguisher that was taken out of service and replaced with an ABC dry chemical extinguisher.

### 3.5.2 NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAPS)

In 1970 the CAA established standards to protect the general public from pollutants that may result in an increase in mortality or an increase in serious irreversible or incapacitating illnesses. These regulations, known as NESHAPs, were updated significantly in 1990. To protect against the effects of these pollutants, EPA developed a program to limit emissions of 189 toxic air pollutants. This program includes a list of regulated contaminants, a schedule for implementation of 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 BNL Title V Phase II application, the Laboratory 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 no proposed or promulgated Maximum Available Control Technology standards were applicable to BNL operations. Additional evaluation conducted in 2000 determined that no Maximum Avail-

able Control Technology standards were applicable to anticipated emissions from proposed activities or operations.

#### 3.5.2.2 ASBESTOS

As required, BNL provided advance notice to the EPA Region II office regarding the demolition of three structures, none of which were constructed with asbestos containing materials. The Laboratory also provided the EPA with an annual notice of unscheduled small renovations for 2000 involving asbestos containing materials. During 2000, 821 linear feet (299 meters) of asbestos-containing pipe insulation and 23 square feet (2.1 square meters) of asbestos-containing surface material were removed and disposed of in accordance with requirements.

#### 3.5.2.3 RADIOACTIVE AIRBORNE EMISSIONS

Emissions of radiological contaminants are evaluated, and if necessary monitored, to ensure that there is no impact to the environment resulting from these emissions. A full description of the monitoring conducted in 2000 is provided in Chapter 4. All data pertaining to radioactive air emissions and dose calculations were transmitted to EPA on schedule, in fulfillment of the June 30 annual reporting requirement. In 2000, the maximum offsite dose due to airborne radioactive emissions from the Laboratory continued to be far below the 10 mrem (100 μSv) annual dose limit specified in 40 CFR 61 Subpart H (see Chapter 4 for more information on the estimated air dose). The dose to the maximally exposed individual resulting from airborne emissions, calculated using EPA's CAP88-PC (CAA Assessment Package-2000) model, was 0.18 mrem (1.8 μSV) (see Section 8.2.4).

### 3.6 CLEAN WATER ACT (CWA)

The disposal of wastewater by Laboratory operations is regulated under the CWA, as implemented by NYSDEC and under DOE Order 5400.5 (1990). The goal of the CWA is 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. The NYSDEC SPDES permit regulates wastewater effluents at BNL. This permit establishes release concentration limits and specifies monitoring requirements.

The BNL SPDES permit was renewed in September 1999 with an effective date of March 1, 2000. This permit provides monitoring requirements and specifies effluent limits for 12 of 14 outfalls:

- Outfall 001 is the discharge of treated effluent from the Sewage Treatment Plant (STP) to the Peconic River.
- Outfalls 002, 002A, 002B, 003, 004, 005, 006A, 006B, 008, 010, and 011 are recharge basins used for the discharge of cooling tower blowdown, once-through cooling water, and/or stormwater. There was no monitoring of Outfalls 002A and 002B in 2000 since the RHIC cooling towers operated infrequently. No monitoring requirements are imposed for Outfall 011.
- 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. There are no monitoring requirements imposed for this outfall.

See Figures 5-2 and 5-7 in Chapter 5 for locations of BNL outfalls.

Each month BNL prepares a Discharge Monitoring Report that reports monitoring data, evaluates compliance with permit limitations and identifies corrective measures taken to address permit excursions. This report is submitted directly to the NYSDEC central and regional offices, and the Suffolk County Department of Health Services.

#### 3.6.1 OUTFALL 001 - SEWAGE TREATMENT PLANT (STP)

Sanitary and process wastewater generated by Laboratory operations is conveyed to the STP for treatment prior to discharge to the Peconic River. The STP provides tertiary treatment of sanitary and process wastewater (i.e., biological reduction of organic matter and reduction of nitrogen). This treatment process became fully functional in 1998. Chapter 5, Section 5.2 provides a detailed description of the treatment process.

A summary of the non-radiological monitoring results for the STP discharge at Outfall 001 is provided in Table 3-3. The

relevant SPDES permit limits are also shown. BNL monitors the STP discharge for over 100 parameters monthly and well over 200 parameters quarterly. While BNL documents better than 99% overall compliance with effluent limits, there were eight reported exceedances of SPDES permit limits in 2000. Inorganic excursions were the most predominant type of permit exceedance in 2000. Excursions were as follows:

- *Zinc*. Zinc in the STP discharge exceeded permit limits on four occasions, two in May and two in December. The source of the zinc excursions is currently under investigation. One potential source being reviewed is the sewage piping system upgrades started in late 1999. This project involved the removal of roots, the cleaning of the lines, and the replacement or relining of pipes with a fiberglass sleeve in damaged areas. Experimental and operational sources are also being reviewed to ensure wastewater is being properly managed at the source.
- *Iron*. Iron was detected in June at a concentration of 0.5 mg/L. Iron was most likely due to discharge of natural sediments released during excavation of sand filters.
- *Percent Suspended Solids (TSS) Removal*. There was one permit excursion for TSS removal in 2000. The BNL SPDES permit requires that 85% of all incoming suspended solids be removed during the treatment process. Due to low levels of solids in the influent, 85% reduction cannot always be documented due to the limitations of the analytical methods.
- *Average and Maximum Fecal Coliform*. The BNL STP uses ultraviolet light disinfection for bacteriological control. This process has operated uninterrupted since its installation in 1998 and has proven highly effective for control of bacteria. However a single sample collected in 2000 exhibited a fecal coliform concentration of 900 MPN/100 ml. Due to the high efficiency of the disinfection system and its proven performance and continuous operation, this excursion is suspect and may be the result of cross contamination or contamination of sample collection containers or equipment.
- *Perchloroethylene*. While not required by permit, the BNL monitors the STP discharge for 38 organic compounds monthly. With the exception of low level detections of disinfection by-products (e.g., chloroform) organic compounds are not detected in the discharge. In June, a single sample exhibited perchloroethylene at 31 µg/L. This finding was reported to the NYSDEC and exceeds the New York State ambient water quality standards of 5 µg/L. While perchloroethylene is routinely detected in commercial spot removers, the STP process should remove this contaminant. Based upon STP operational history and review of BNL operations, this result is suspected of resulting from cross contamination either during sample collection or analysis. BNL will continue to monitor for perchloroethylene as part of its routine monitoring program.

Figures 3-1 through 3-6 plot five-year trends for the maximum monthly concentrations of iron, lead, mercury, silver, nickel, and zinc in the STP discharge.

#### 3.6.1.1 CHRONIC TOXICITY TESTING

The SPDES permit requires that the Laboratory conduct whole effluent toxicity testing to ensure that chemicals present in the STP effluent are not toxic to aquatic organisms. The chronic toxicity testing program was initiated in 1993 and continued in 2000. Samples were collected and tested quarterly. The program consists of performing seven-day chronic toxicity tests on two fresh water organisms: water fleas (*Ceriodaphnia dubia*) and fathead minnows (*Pimephales promelas*). Sets of ten animals were exposed to varying concentrations of the STP effluent (100, 50, 25, 12.5, and 6.25%) for seven days in each test. During testing, the size of fish and/or rate of reproduction for the water flea were measured and compared to untreated organisms (i.e., controls). The test results were submitted to NYSDEC for review.

The toxicity data showed there was no acute toxicity exhibited for either organism, nor were any chronic effects, such as changes in growth weight, noted for the minnow. However, in September the rate of reproduction for the water fleas raised in the pure STP effluent was lower than the control group. To assess the reproduction rates of natural organisms in the Peconic River, samples of river water were collected upstream of the STP discharge and analyzed simultaneously in June. The reproduction rates in the pure river water were just over 2 neonates (i.e., offspring) per surviving female

**Table 3-3. Analytical Results for Wastewater Discharges to Sewage Treatment Plant Outfall 001 (CY 2000).**

| Analyte | Min. | Max. | Min. Monitoring Frequency | SPDES Limit | No. of Exceedances | % Compliance* |
|---|---|---|---|---|---|---|
| Max. Temperature (°F) | 52 | 77 | Daily | 90 | 0 | 100 |
| pH (SU) | 5.8 | 7.7 | Continuous Recorder | Min. 5.8<br>Max. 9.0 | 0 | 100 |
| Avg. 5-Day BOD (mg/L) | < 2 | 5 | Twice Monthly | 10 | 0 | 100 |
| Max. 5-Day BOD (mg/L) | < 2 | 8 | Twice Monthly | 20 | 0 | 100 |
| % BOD Removal | > 83 | 97 | Monthly | 85 | 0[a] | 100 |
| Avg. TSS (mg/L) | < 4 | < 4 | Twice Monthly | 10 | 0 | 100 |
| Max. TSS (mg/L) | < 4 | < 4 | Twice Monthly | 20 | 0 | 100 |
| % TSS Removal | > 73 | 99 | Monthly | 85 | 1[b] | 92 |
| Settleable Solids (ml/L) | 0.0 | 0.0 | Daily | 0.1 | 0 | 100 |
| Ammonia Nitrogen (mg/L) | < 0.05 | 1.1 | Twice Monthly | 2 | 0 | 100 |
| Total Nitrogen (mg/L) | 5.8 | 8.0 | Twice Monthly | 10 | 0 | 100 |
| Total Phosphorus (mg/L) | 0.4 | 1.5 | Twice Monthly | NA | 0 | 100 |
| Cyanide (μg/L) | < 10 | < 10 | Twice Monthly | 100 | 0 | 100 |
| Copper (mg/L) | 0.04 | 0.06 | Twice Monthly | 0.15 | 0 | 100 |
| Iron (mg/L) | 0.01 | 0.5 | Twice Monthly | 0.37 | 1[c] | 96 |
| Lead (mg/L) | < 0.001 | 0.005 | Twice Monthly | 0.019 | 0 | 100 |
| Nickel (mg/L) | 0.003 | 0.01 | Twice Monthly | 0.11 | 0 | 100 |
| Silver (mg/L) | 0.001 | 0.006 | Twice Monthly | 0.015 | 0 | 100 |
| Zinc (mg/L) | 0.01 | 0.15 | Twice Monthly | 0.1 | 4[d] | 86 |
| Mercury (mg/L) | < 0.0001 | 0.0002 | Twice Monthly | 0.0008 | 0 | 100 |
| Toluene (μg/L) | < 1 | < 1 | Twice Monthly | 5 | 0 | 100 |
| Methylene Chloride (μg/L) | < 1 | < 1 | Twice Monthly | 5 | 0 | 100 |
| 1,1,1-Trichloroethane (μg/L) | < 1 | < 1 | Twice Monthly | 5 | 0 | 100 |
| 2-Butanone (μg/L) | < 1 | < 5 | Twice Monthly | 50 | 0 | 100 |
| PCBs (μg/L) | < 0.065 | 0.053 | Quarterly | NA | 0 | 100 |
| Max. Flow (MGD) | 0.6 | 1.9 | Continuous Recorder | 2.3 | 0 | 100 |
| Avg. Flow (MGD) | 0.5 | 0.7 | Continuous Recorder | NA | 0 | 100 |
| Avg. Fecal Coliform (MPN/100 ml) | < 2 | 451 | Twice Monthly | 200 | 1[e] | 96 |
| Max Fecal Coliform (MPN/100 ml) | < 2 | 900 | Twice Monthly | 400 | 1[e] | 96 |

Notes:
See Chapter 5, Figure 5-7 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] The calculated % BOD removal was greater than 83 percent in November. The 5-day BOD results were below the analytical detection limit, and, therefore, the actual percent removal cannot be precisely determined.

[b] A permit exceedance occurred in April due to low levels of solids entering the sewage treatment plant. STP effluent levels of suspended solids were below the permit limits. The February percent removal could not be accurately determined due to the low concentration measured in the influent and effluent to the sewage treatment plant.

[c] A permit exceedance occurred in June of 2000. An investigation revealed that the Plant Engineering Division had performed tests within the sand filter beds at the Sewage Treatment Plant during the last part of May. The filter beds contain elevated levels of iron and therefore this is the most probable cause of the permit violation.

[d] There were permit exceedances in May and December of 2000. The December 2000 violations were most probably due to sewer upgrades being performed onsite during November and December.

[e] A permit exceedance occurred in January of 2000. In 1997 the Sewage Treatment Plant was equipped with an ultraviolet disinfection system, which results in low to nondetectable levels of coliform in the effluent. It is, therefore, thought that the violation was due to contaminated glassware or sampling equipment.

Other: A permit exceedance occurred in June of 2000 at the STP effluent for perchloroethylene. Since this is an unpermitted contaminant, the Laboratory cannot discharge this chemical in any concentration. While perchloroethylene is present in many commercially available spot removers, the STP process should remove this contaminant. Since over the last five years there has never been a detection of this compound, the data is questionable.

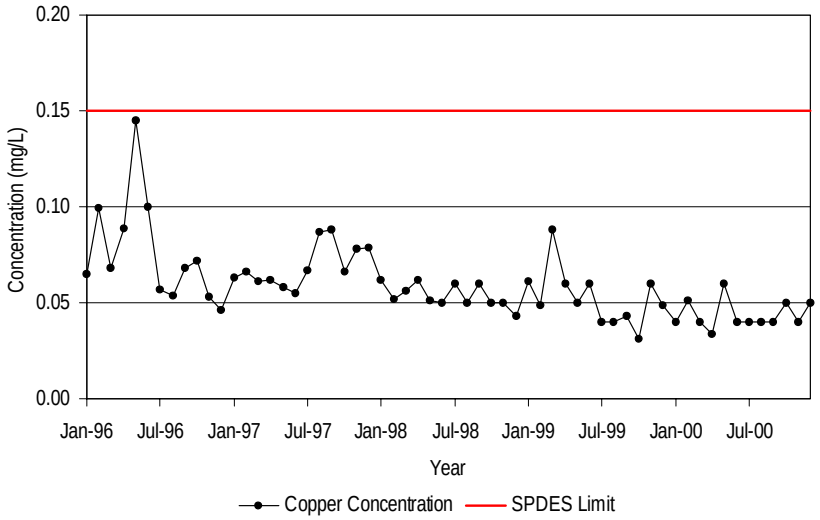



**Figure 3-1.**
**Maximum Concentration of Copper Discharged From the BNL Sewage Treatment Plant, 1996-2000.**

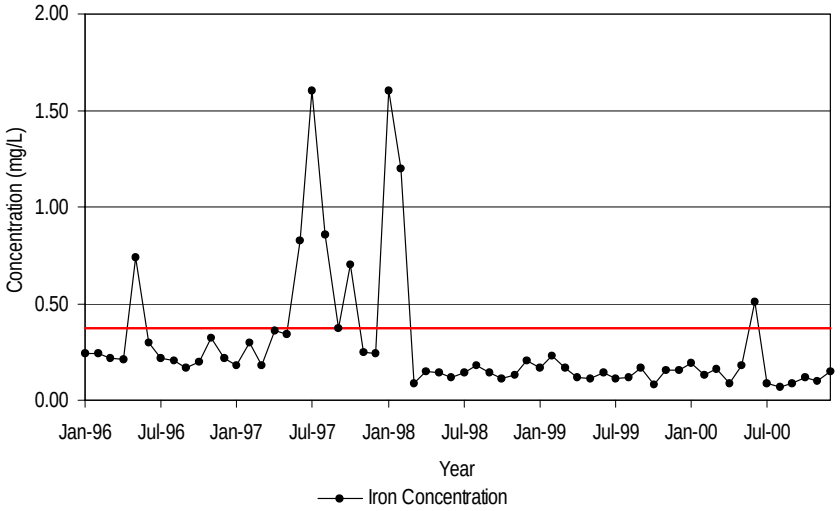



**Figure 3-2.**
**Maximum Concentration of Iron Discharged From the BNL Sewage Treatment Plant, 1996-2000.**

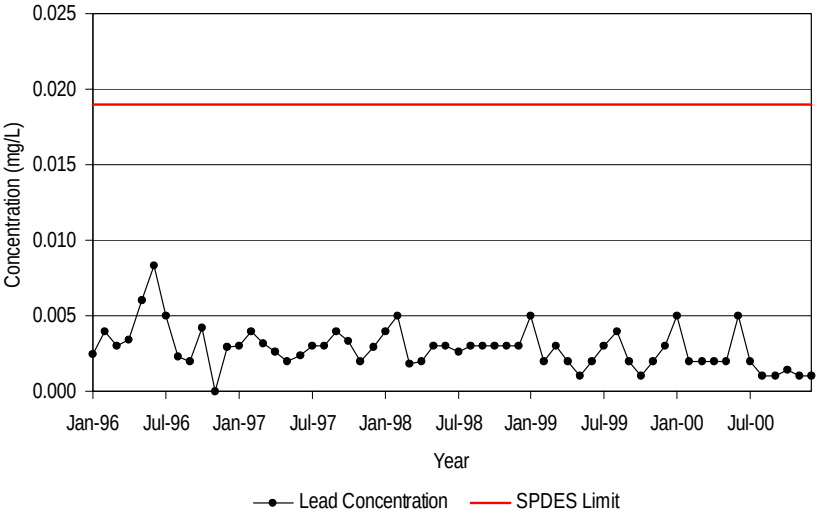



**Figure 3-3.**
**Maximum Concentration of Lead Discharged From the BNL Sewage Treatment Plant, 1996-2000.**

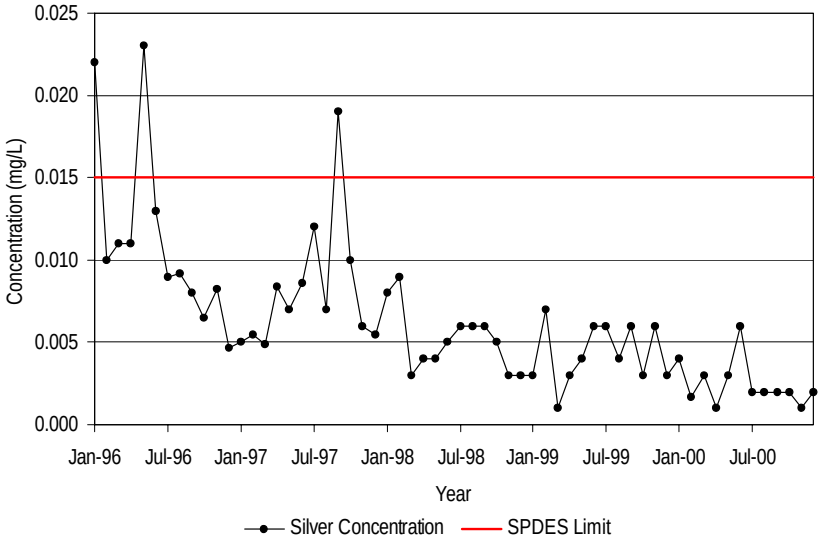



**Figure 3-4.**
**Maximum Concentration of Silver Discharged From the BNL Sewage Treatment Plant, 1996-2000.**

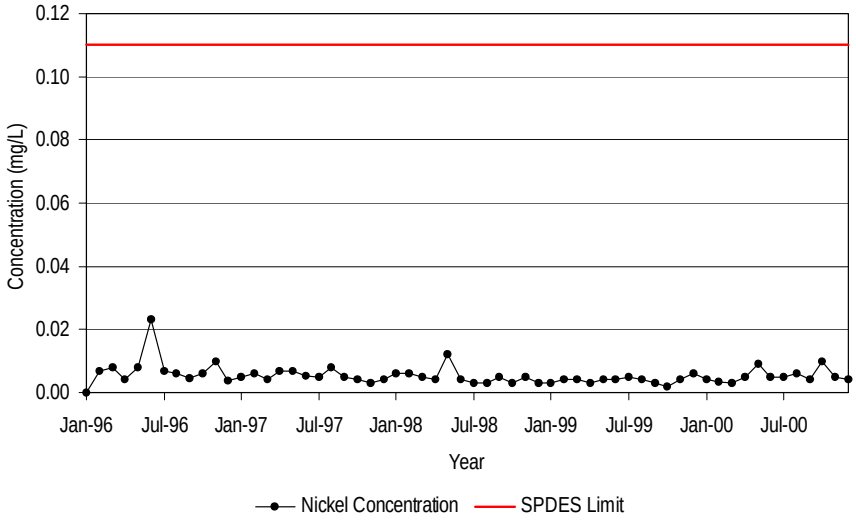



**Figure 3-5.**
**Maximum Concentration of Nickel Discharged From the BNL Sewage Treatment Plant, 1996-2000.**

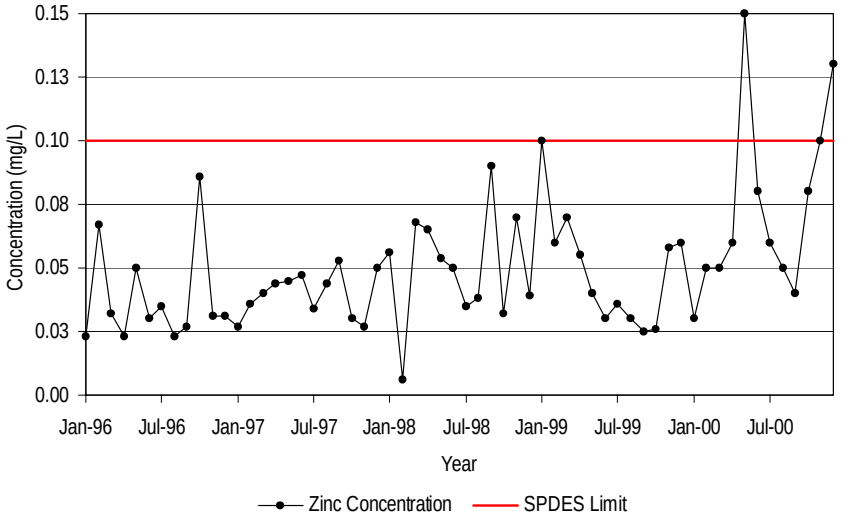



**Figure 3-6.**
**Maximum Concentration of Zinc Discharged From the BNL Sewage Treatment Plant, 1996-2000.**

with a survival rate of 40%. Data for the June STP samples showed survival to be 90% with over 15 neonates per organism. These data show that the Peconic River upstream of the STP had a mild negative impact on water flea survival and reproduction when evaluated in an analytical setting.

#### 3.6.2 OUTFALLS 002 - 008 AND 010 — RECHARGE BASINS AND STORMWATER

Outfalls 002 - 008 and 010 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. There are no monitoring requirements imposed for Outfalls 009 and 011. Monitoring of Outfall 002B was not performed in 2000 and monitoring of Outfall 002A was only conducted in February due to limited operation of the RHIC facility cooling water systems. Table 3-4 summarizes the monitoring requirements along with performance results for 2000.

There were three excursions at these outfalls in 2000. Two were for exceeding effluent limits (oil and grease in Outfall 008, and pH at Outfall 003) and one was for failure to obtain a monitoring result. Elevated pH in the BNL domestic water system was the most probable cause of the pH excursion in Outfall 3. To increase the pH of domestic water and reduce the corrosivity of the water system, hydroxides (either calcium or sodium) are added to the well water. Occasionally, excess lime or caustic is inadvertently added to the system, which results in a slightly elevated pH. The discharge of slightly alkaline wastewater would not be expected to have detrimental effects on groundwater due to the naturally acidic conditions of Long Island groundwater systems. Parking lot runoff from private automobile discharges is the most probable source of the oil and grease violation. The failure to collect and analyze one wastewater sample from Outfall 008 was due to a sampling oversight. Procedures have been established to conduct a closer review of monthly sampling requirements and schedules to prevent any recurrence of this violation.

### 3.7 SAFE DRINKING WATER ACT (SDWA)

The distribution and supply of drinking water is regulated under the federal Safe Drinking Water Act (SDWA). In New York State, implementation of the SDWA is delegated to the New York State Department of Health (NYSDOH) and administered by the Suffolk County Department of Health Services (SCDHS). Since BNL provides potable water to more than 25 full-time residents, it is subject to the requirements for a public water supply. Monitoring requirements are prescribed annually by SCDHS, and a *Potable Water Sampling and Analysis Plan* (Chaloupka 2000a) is prepared to comply with these requirements. The 1996 amendments to the SDWA required preparation of a source water assessment for all sources of public drinking water. In December 2000, the BNL source water assessment was prepared in satisfaction of this requirement (Bennett *et al.* 2000). The Source Water Assessment is designed as a management tool to further protect the sole source aquifer system underlying the BNL site.

#### 3.7.1 POTABLE WATER

BNL maintains six groundwater wells for onsite distribution of potable water. Groundwater is treated with activated carbon or air stripping to remove volatile organic compounds to meet drinking water standards. Groundwater from three of the six wells is also treated to reduce naturally occurring iron. Figure 3-7 shows the treatment process used for removing iron from groundwater.

BNL monitors the potable wells regularly for bacteria, inorganics, organics, and pesticides as required by NYSDOH regulations. BNL also voluntarily monitors drinking water supplies for radiological contaminants. Tables 3-5 and 3-6 provide the potable water supply monitoring data for 2000. Color and iron exceeded drinking water standards in samples collected from three of the wells prior to distribution. Treatment at the Water Treatment Plant effectively reduced these levels to below drinking water standards. At the point of consumption, all drinking water supplies complied with primary drinking water standards during 2000. Iron was detected in a routine distribution sample collected in July at a concentration of 0.35 mg/L, which slightly exceeds the drinking water standard of 0.30 mg/L. Iron occurs naturally in groundwater and is regulated as an aesthetic contaminant and at high concentrations can lead to staining of laundered clothing and porcelain

**Table 3-4. Analytical Data for Wastewater Discharges to Outfalls 002 - 008 and 010 (CY 2000).**

| Analyte | | Outfall 002 | Outfall 003 | Outfall 004 | Outfall 005 | Outfall 006A | Outfall 006B | Outfall 007 | Outfall 008 | Outfall 010 | SPDES Limit | No. of Exceed. | % Comp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flow | N | CR | CR | CR | CR | CR | CR[a] | CR | 11 | 11 | | | |
| (MGD) | Min. | 0.1 | 0.1 | 0.001 | 0.1 | 0.0004 | 0.001 | 0 | 0.001 | 0.0003 | NA | NA | |
| | Max. | 0.3 | 1.1 | 0.2 | 0.4 | 0.3 | 0.3 | 0.6 | 0.9 | 2.1 | NA | NA | |
| pH | Min. | 6.3 | 6.2 | 5.9 | 6.2 | 6.6 | 6.8 | 6.6 | 6.4 | 6.3 | NA | NA | |
| (SU) | Max. | 8.5 | 10.1 | 7.6 | 8.5 | 8.9 | 8.4 | 7.5 | 7.9 | 7.8 | 8.5, 9.0[b] | 1 | 96 |
| Oil and | N | 12 | 12 | NR | 12 | 12 | 12 | NR | 11 | 11 | | | |
| Grease | Min. | < 5 | < 5 | NR | < 5 | < 5 | < 5 | NR | < 5 | < 5 | NA | NA | |
| (mg/L) | Max. | 6.3 | 6.1 | NR | 5.9 | 6.1 | 6.6 | NR | 17.3 | 11.1 | 15 | 1 | 99 |
| Copper | N | NR | NR | NR | 4 | NR | NR | NR | NR | NR | | | |
| (mg/L) | Min. | NR | NR | NR | 0.004 | NR | NR | NR | NR | NR | NA | NA | |
| | Max. | NR | NR | NR | 0.02 | NR | NR | NR | NR | NR | 1.0 | 0 | 100 |
| Zinc | N | NR | 4 | NR | NR | NR | NR | NR | NR | NR | | | |
| (mg/L) | Min. | NR | 0.003 | NR | NR | NR | NR | NR | NR | NR | NA | NA | |
| | Max | NR | 0.02 | NR | NR | NR | NR | NR | NR | NR | 5 | 0 | 100 |
| Iron (total) | N | NR | NR | NR | NR | NR | NR | 9 | NR | NR | | | |
| (mg/L) | Min. | NR | NR | NR | NR | NR | NR | 80 | NR | NR | NA | NA | |
| | Max. | NR | NR | NR | NR | NR | NR | 375 | NR | NR | NA | 0 | 100 |
| Iron (dissolved) | N | NR | NR | NR | NR | NR | NR | 9 | NR | NR | | | |
| (mg/L) | Min. | NR | NR | NR | NR | NR | NR | 0.2 | NR | NR | NA | NA | |
| | Max. | NR | NR | NR | NR | NR | NR | 1.4 | NR | NR | NA | 0 | 100 |
| Chloroform | N | 4 | NR | NR | NR | NR | NR | NR | NR | NR | | | |
| (µg/L) | Min. | < 1 | NR | NR | NR | NR | NR | NR | NR | NR | NA | NA | |
| | Max. | < 1 | NR | NR | NR | NR | NR | NR | NR | NR | 7 | 0 | 100 |
| Bromo- | N | 4 | NR | NR | NR | NR | NR | NR | NR | NR | | | |
| dichloromethane | Min. | < 1 | NR | NR | NR | NR | NR | NR | NR | NR | NA | NA | |
| (µg/L) | Max. | < 1 | NR | NR | NR | NR | NR | NR | NR | NR | 5 | 0 | 100 |
| 1,1,1-trichloroethane | N | 4 | 4 | 4 | NR | NR | NR | NR | 3[c] | NR | | | |
| (µg/L) | Min. | < 1 | < 1 | < 1 | NR | NR | NR | NR | < 1 | NR | NA | NA | |
| | Max. | < 1 | < 1 | < 1 | NR | NR | NR | NR | < 1 | NR | 5 | 1 | 93 |
| 1,1-dicloroethylene | N | NR | NR | 4 | NR | NR | NR | NR | 3[c] | NR | | | |
| (µg/L) | Min. | NR | NR | < 1 | NR | NR | NR | NR | < 1 | NR | NA | NA | |
| | Max. | NR | NR | < 1 | NR | NR | NR | NR | < 1 | NR | 5 | 1 | 93 |
| Dibromo-nitrilo- | N | NR | 4 | NR | NR | NR | NR | NR | NR | NR | | | |
| propionimide | Min. | NR | < 0.005 | NR | NR | NR | NR | NR | NR | NR | NA | NA | |
| (mg/L) | Max. | NR | < 0.005 | NR | NR | NR | NR | NR | NR | NR | 0.5 | 0 | 100 |
| Hydroxyethylidene- | N | 4 | 4 | NR | 4 | 4 | 4 | NR | NR | NR | | | |
| diphosphonic Acid | Min. | < 0.05 | < 0.05 | NR | < 0.05 | < 0.05 | < 0.05 | NR | NR | NR | NA | NA | |
| (mg/L) | Max. | < 0.05 | 0.06 | NR | 0.05 | 0.006 | 0.05 | NR | NR | NR | 0.5 | 0 | 100 |
| Tolyltriazole | N | 4 | 4 | NR | 4 | 4 | 4 | NR | NR | NR | | | |
| (mg/L) | Min. | < 0.005 | < 0.005 | NR | < 0.005 | < 0.005 | < 0.005 | NR | NR | NR | NA | NA | |
| | Max. | < 0.005 | < 0.005 | NR | < 0.005 | 0.06 | < 0.005 | NR | NR | NR | 0.2 | 0 | 100 |

Notes:
See Chapter 5, Figure 5-7 for locations of outfalls.
There are no monitoring requirements for Outfall 009 and Outfall 011.
CR = Continuous Recorder
MGD = Million Gallons per Day
Max. = Maximum value
Min. = Minimum value
N = Number of samples
NA = Not Applicable
NR = Analysis Not Required
SU = Standard Unit
[a] Flow estimated for part of year due to damaged equipment resulting from a lightning strike.
[b] pH limit is 8.5 for Outfalls 004, 005, 008, and 010. pH limit is 9.0 for Outfalls 002, 003, 006A, 006B, and 007.
[c] Quarterly samples for volatile organic analysis were not collected in June due to sampling error.

# How Does BNL Produce Its Drinking Water?

*Drawn from wells tapped into Long Island's Glacial Aquifer, BNL's drinking water last year, as in the past, was in full compliance with all county, state, and federal regulations.*

*In fact, the Lab's Plant Engineering (PE) Division, which is responsible for the Lab's drinking water, is proud to report that Brookhaven's water system has not violated any water quality standard.*

*So, how does the Lab produce drinking water which is purified, safe, and high quality? And who produces it?*

*This water is produced with pride by the staff of BNL's Water Treatment Facility (WTF) of the Plant Engineering Division, using what is identified as "federal public water system No. 511891." This community water system is the only source on site of what is called potable water for BNL's transient and resident population of 3,500 people.*

*The centerpiece of the Lab's drinking water system is the Water Treatment Facility (WTF), located in and around Bldg. 624 on Upton Road. The WTF was built in 1963 to remove iron and manganese from the Lab's source water, but the facility has undergone a series of upgrades over the years, most recently in 1995-96.*

*While there are six drinking water wells on site, the water from only three wells (numbered 4, 6, and 7) is delivered to the WTF because that water is high in iron. Water from the other three wells (numbered 10, 11, and 12) is low in iron, so that water is distributed directly, after passing through activated carbon filters.*

*Drinking water production is the role and responsibility of Water System Supervisor Tony Ross, who holds a New York State Department of Health (NYSDOH) grade IA certification. He is assisted by seven water treatment engineers, each having a NYSDOH grade IIA certification. They are: Steve Barcelo, Tom Boucher, Chris Hanley, Jack Kulesa, Richard Lutz, Phil Pizzo, and Joe Tullo. WTF operations are overseen by William Chaloupka, PE Assistant Manager of Operations & Environment. - Marsha Belford*

*The flow of water through the Lab's supply system and the on-the-job performance of the WTF staff are shown in photos by Roger Stoutenburgh and described below.*

1A

1A. WELLS 4, 6, and 7: provide source water high in iron that is "finished" at BNL's Water Treatment Facility (WTF). At one of these wells, Phil Pizzo performs preventive maintenance on pump motor.

1B. CARBON FILTRATION AT WELLS 10, 11, and 12: removes any volatile organic compounds before the low-iron water from these wells directly enters the drinking water distribution system. Noting the pressure of the carbon filtration system is Richard Lutz.

2. CHLORINATION: of water from Wells 4,6, and 7 is performed at this point to kill bacteria and oxidize the iron in the water. Iron removal by oxidation and filtration reduces the water's iron concentration from 3 to 4 milligrams per liter (mg/l) to the "finished" water's 0.03 mg/l. Inspecting a liquid sodium hypochlorite storage tank is Joe Tullo.

3. AERATION TANK: reduces carbon dioxide gas and aids in the oxidation of iron. At the aeration tank, Steve Barcelo (right) describes the action to Frank Masia.

1B

2

3

**Figure 3-7. Potable Water Treatment at BNL**
*(Reproduced with permission from The Bulletin [BNL 2001a]).*

4

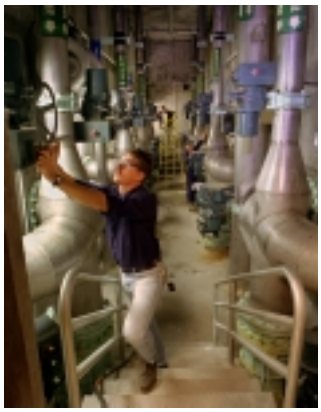
4. LIME: is added after aeration (no. 3) and before retention (no. 6) to raise the pH and soften the water. Feeding lime into the hopper is Steve Barcelo.

5

5. POLYMER: is also added to the water after aeration to aid in a process called flocculation, whereby very small hydroxide particles stick together to form larger particles, called floc, which are more easily settled and removed (see no. 6). The polymer is mixed with the water in a rapid-mix tank. Steve Barcelo (left) is seen measuring the polymer, while Tom Boucher prepares to mix.

6

6. RETENTION TANK: holds the water long enough to allow the chemicals time to react and form floc. To aid in the formation of floc, the water is then sent to a slow-mix tank. At the retention tank are: (from left) Steve Barcelo, Jack Kulesa (who is checking for floc particles), and Richard Lutz, plus Frank Masia.

7


7. FILTRATION: is performed, using what is called a rapid sand filter made up of eight filter cells containing sand and anthracite. Inspecting the valves in the filtration valve gallery are: (front to back) Jack Kulesa, Richard Lutz, and Steve Barcelo.

8. WET WELL: stores the filtered water before it is pumped into the air-stripping towers. While Jack Kulesa (background) is seen inspecting the wet-well pump seals, Richard Lutz works on a check valve.

8

9. AIR-STRIPPING TOWERS: remove any volatile organic compounds (VOCs) from the water undergoing the WTF process by spraying the water down over whiffle ball-like fill while air flows upward through the water spray. Inspecting the towers from the top is Steve Barcelo. Frank Masia looks on from below.

9

10. CLEAR WELL: stores what is now called "finished" water before its final chlorination and distribution. Seen taking a water sample at the clear well are Jack Kulesa (right) and Richard Lutz (left).

11. HIGH-SERVICE PUMPS: send the finished water from the WTF to the two water towers on site. Adjusting the flow rate of a high-service pump is Steve Barcelo.

10

12. ONE-MILLION-GALLON WATER STORAGE TOWER: as viewed from its base, is the larger of the Lab's two water towers. Built in 1985, and located at Cornell and North Sixth Street, this tank is 126 feet above the ground; its bowl is 75.5 feet in diameter. Located next to Police Headquarters, Bldg. 50, the other water storage tank holds 300,000 gallons and was built for the U.S. Army in 1941, when the site was Camp Upton. Water from the two towers is delivered on site via 45 miles of distribution pipe, which is a mix of cast iron dating from World War II Camp Upton, transite, plastic, and cement-lined ductile iron. When distribution pipe is added or replaced, cement-line ductile iron is used.

11

12

13. TESTING THE QUALITY OF BNL'S DRINKING WATER: at the WTF is Tom Boucher. The Lab's drinking water is tested in various locations weekly, monthly, quarterly, semi-annually, and annually, depending upon the specific test. Test samples are analyzed by certified laboratories, and results are reported to the Suffolk County Department of Health Services, which conducts its own annual tests of all county water systems. In addition, the results are delivered to BNL's Environmental Services Division, which ensures that the Lab's water is in compliance with all applicable regulations. The results are summarized in the Lab's annual Water Quality Consumer Confidence Report (BNL 2001b).

13

For answers to frequently asked questions about BNL's drinking water quality, go to www.bnl.gov/bnlweb/pubaf/water/waterFAQ.pdf

**Table 3-5. Potable Water Wells and Potable Distribution System: Bacteriological, Inorganic Chemical, and Radiological Analytical Results (CY 2000).**

| 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) | 40* | 50* | 20* | 5 | < 5 | < 5 | 5 | 15 |
| Odor (Units) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Cyanide (μg/L) | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | NS |
| Conductivity (mmhos/cm) | 105 | 84 | 116 | 184 | 291 | 311 | 221 | NS |
| Chlorides (mg/L) | 17.5 | 12.3 | 20.7 | 11.0 | 21.9 | 12.3 | 23.2 | 250 |
| Sulfates (mg/L) | 26.4 | 16.8 | < 5.0 | 7.7 | < 5.0 | < 5.0 | 11.6 | 250 |
| Nitrates (mg/L) | 0.26 | 0.20 | 0.32 | 0.21 | 0.50 | 0.41 | 0.57 | 10 |
| Nitrites (mg/L) | 0.10 | 0.10 | < 0.01 | 0.02 | < 0.01 | < 0.01 | < 0.01 | 1.0 |
| Ammonia (mg/L) | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | NS |
| pH (Standard Units) | 6.0 | 6.0 | 6.0 | 6.1 | 6.1 | 6.8 | 7.0 | NS |
| MBAS (mg/L) | < 0.08 | < 0.08 | < 0.08 | < 0.08 | < 0.08 | < 0.08 | < 0.08 | NS |
| **Metals** | | | | | | | | |
| Antimony (μg/L) | < 0.8 | < 0.8 | < 0.8 | < 0.8 | < 0.8 | < 0.8 | < 5.9 | 6.0 |
| Arsenic (μg/L) | 1.8 | 0.8 | 1.1 | < 0.8 | < 0.8 | < 0.8 | < 3.0 | 50 |
| Barium (mg/L) | 0.03 | 0.02 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 2.0 |
| Beryllium (μg/L) | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 3.0 | 4.0 |
| Cadmium (μg/L) | < 0.6 | < 0.6 | < 0.6 | < 0.6 | < 0.6 | < 0.6 | < 5.0 | 5.0 |
| Chromium (mg/L) | 0.002 | 0.002 | < 0.002 | < 0.002 | < 0.002 | < 0.002 | 0.002 | 0.1 |
| Fluoride (mg/L) | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | 2.2 |
| Iron (mg/L) | 6.4 * | 4.6 * | 1.6 * | 0.3 | 0.01 | 0.02 | 0.35 | 0.3 |
| Lead (μg/L) | 1.3 | 3.6 | < 0.5 | 2.1 | 0.8 | < 0.5 | 2.2 | 15 |
| Manganese (mg/L) | 0.2 | 0.08 | 0.06 | 0.01 | 0.001 | <0.001 | 0.2 | 0.3 |
| Mercury (μg/L) | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.2 | 2.0 |
| Nickel (mg/L) | < 0.002 | 0.005 | 0.003 | < 0.002 | < 0.002 | < 0.002 | 0.004 | 0.1 |
| Selenium (μg/L) | 1.0 | 0.7 | < 0.7 | < 0.7 | < 0.7 | < 0.7 | < 5.0 | 50.0 |
| Sodium (mg/L) | 12.4 | 8.9 | 11.6 | 13.4 | 14.4 | 11.5 | 32.2 | NS |
| Silver (μg/L) | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 100 |
| Thallium (μg/L) | 0.7 | 0.5 | < 0.5 | < 0.5 | 0.6 | 0.8 | < 1.9 | 2.0 |
| Zinc (mg/L) | 0.005 | 0.02 | 0.005 | 0.02 | 0.005 | 0.002 | 0.03 | 5.0 |
| **Radioactivity** | | | | | | | | |
| Gross Alpha Activity (pCi/L) | 1.1 | 1.3 | < 1.1 | 1.0 | < 1.1 | < 1.1 | NR | 15.0 |
| Beta (pCi/L) | 13.1 | 6.1 | 3.3 | 2.8 | 5.2 | 5.2 | NR | 50.0 |
| Tritium (pCi/L) | < 353 | < 353 | < 353 | < 353 | < 353 | < 353 | NR | 20,000 |
| Strontium-90 (pCi/L) | < 0.7 | < 0.6 | < 0.7 | < 0.4 | < 0.7 | < 0.6 | NR | 8.0 |
| **Other** | | | | | | | | |
| Asbestos (M. Fibers/L) | NR | NR | NR | NR | NR | NR | < 0.7 | 7 |
| Calcium (mg/L) | NR | NR | NR | NR | NR | NR | 10.5 | NS |
| Alkalinity (mg/L) | NR | NR | NR | NR | NR | NR | 60.4 | NS |

Notes:
See Chapter 7, Figure 7-5 for well locations. This table contains the maximum concentration (minimum pH value) reported by the analytical laboratory.
MBAS = Methylene Blue Active Substances
ND = Not Detected
NR = Analysis Not Required
NS = Drinking Water Standard Not Specified
NYS DWS = New York State Drinking Water Standard
* Wells are treated at the WTP for color and iron reduction prior to site distribution.

fixtures. There are no health effects associated with iron consumed at this level. Section 7.4 of Chapter 7 provides additional data on environmental surveillance testing performed on potable wells. This additional testing exceeds the minimum SDWA testing requirements.

### 3.7.2 CROSS-CONNECTION CONTROL

The SDWA requires that public water suppliers implement practices to protect the public water supply from sanitary hazards, including the protection of potable water supply connections to systems containing

**Table 3-6. Potable Water Wells: Analytical Results for Principal Organic Compounds, Synthetic Organic Chemicals, Pesticides, and Micro-Extractables (CY 2000).**

| 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 |
| Fluorotrichloromethane | < MDL | < MDL | < MDL | < MDL | < MDL | < MDL | < MDL | 5 |
| 1,1-dichloroethene | < MDL | < MDL | < MDL | < MDL | < MDL | < MDL | < MDL | 5 |
| Dichloromethane | < 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 | < MDL | < MDL | 0.5[(a)] | < MDL | 0.5 | 1.3 | < 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 |
| 1,1,2-trichloroethane | < 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 |
| Trihalomethanes | 4.3 | 4.9 | 1.5 | 7.2 | 3.3 | < MDL | 1.0 | 100 |
| 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 | ND | ND | ND | ND | ND | ND | ND | 5 |
| 2-chlorotoluene | ND | ND | ND | ND | ND | ND | ND | 5 |
| 4-chlorotoluene | ND | ND | ND | ND | ND | ND | ND | 5 |
| 1,3-dichlorobenzene | ND | ND | ND | ND | ND | ND | ND | 5 |
| 1,4-dichlorobenzene | ND | ND | ND | ND | ND | ND | ND | 5 |
| 1,2-dichlorobenzene | ND | ND | ND | ND | ND | ND | ND | 5 |
| 1,2,4-trichlorobenzene | ND | ND | ND | ND | ND | ND | ND | 5 |
| Hexachlorobutadiene | ND | ND | ND | ND | ND | ND | ND | 5 |
| 1,2,3-trichlorobenzene | ND | ND | ND | ND | ND | ND | ND | 5 |
| Benzene | ND | ND | ND | ND | ND | ND | ND | 5 |
| Toluene | ND | ND | ND | ND | ND | ND | ND | 5 |
| Ethylbenzene | ND | ND | ND | ND | ND | ND | ND | 5 |

*(continued on next page)*

**Table 3-6. Potable Water Wells: Analytical Results for Principal Organic Compounds, Synthetic Organic Chemicals, Pesticides and Micro-Extractables (CY 2000)** *(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 | | | | | | | |
| m-xylene | ND | ND | ND | ND | ND | ND | ND | 5 |
| p-xylene | ND | ND | ND | ND | ND | ND | ND | 5 |
| o-xylene | ND | ND | ND | ND | ND | ND | ND | 5 |
| Styrene | ND | ND | ND | ND | ND | ND | ND | 5 |
| Isopropylbenezene | ND | ND | ND | ND | ND | ND | ND | 5 |
| n-propylbenzene | ND | ND | ND | ND | ND | ND | ND | 5 |
| 1,3,5-trimethylbenzene | ND | ND | ND | ND | ND | ND | ND | 5 |
| tert-butylbenzene | ND | ND | ND | ND | ND | ND | ND | 5 |
| 1,2,4-trimethylbenzene | ND | ND | ND | ND | ND | ND | ND | 5 |
| sec-butylbenzene | ND | ND | ND | ND | ND | ND | ND | 5 |
| p-isopropyltoluene | ND | ND | ND | ND | ND | ND | ND | 5 |
| n-butylbenzene | ND | ND | ND | ND | ND | ND | ND | 5 |
| methyl tert. Butylether | ND | ND | ND | ND | ND | ND | ND | 50 |
| Lindane | ND | ND | ND | ND | ND | ND | ND | 0.2 |
| Heptaclor | ND | ND | ND | ND | ND | ND | ND | 0.4 |
| Aldrin | ND | ND | ND | ND | ND | ND | ND | 5 |
| Heptachlor Epoxide | ND | ND | ND | ND | ND | ND | ND | 0.2 |
| Dieldrin | ND | ND | ND | ND | ND | ND | ND | 5 |
| Endrin | ND | ND | ND | ND | ND | ND | ND | 0.2 |
| Methoxychlor | ND | ND | ND | ND | ND | ND | ND | 40 |
| Toxaphene | ND | ND | ND | ND | ND | ND | ND | 3 |
| Chlordane | ND | ND | ND | ND | ND | ND | ND | 2 |
| Total PCB's | ND | ND | ND | ND | ND | ND | ND | 0.5 |
| 2,4,5,-TP (Silvex) | ND | ND | ND | ND | ND | ND | ND | 10 |
| Dinoseb | ND | ND | ND | ND | ND | ND | ND | 50 |
| Dalapon | ND | ND | ND | ND | ND | ND | ND | 50 |
| Pichloram | ND | ND | ND | ND | ND | ND | ND | 50 |
| Dicamba | ND | ND | ND | ND | ND | ND | ND | 50 |
| Pentachlorophenol | ND | ND | ND | ND | ND | ND | ND | 1 |
| Hexachlorcyclopentadiene | ND | ND | ND | ND | ND | ND | ND | 5 |
| Di(2-ethylhexyl)Phthalate | ND | ND | ND | ND | ND | ND | ND | 50 |
| Di(2-ethylhexyl)Adipate | ND | ND | ND | ND | ND | ND | ND | 50 |
| Hexachlorobenzene | ND | ND | ND | ND | ND | ND | ND | 5 |
| Benzo(A)Pyrene | ND | ND | ND | ND | ND | ND | ND | 50 |
| Aldicarb Sulfone | ND | ND | ND | ND | ND | ND | ND | SNS |
| Aldicarb Sulfoxide | ND | ND | ND | ND | ND | ND | ND | SNS |
| Aldicarb | ND | ND | ND | ND | ND | ND | ND | SNS |
| Oxamyl | ND | ND | ND | ND | ND | ND | ND | 50 |
| 3-Hydroxycarbofuran | ND | ND | ND | ND | ND | ND | ND | 50 |
| Carbofuran | ND | ND | ND | ND | ND | ND | ND | 40 |

*(continued on next page)*

**Table 3-6. Potable Water Wells: Analytical Results for Principal Organic Compounds, Synthetic Organic Chemicals, Pesticides and Micro-Extractables (CY 2000)** *(concluded)*.

| 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 | | | | | | | |
| Carbaryl | ND | ND | ND | ND | ND | ND | ND | 50 |
| Total Aldicarbs | ND | ND | ND | ND | ND | ND | ND | SNS |
| Glyphosate | ND | ND | ND | ND | ND | ND | ND | 50 |
| Diquat | ND | ND | ND | ND | ND | ND | ND | 50 |
| Ethylene Dibromide | ND | ND | ND | ND | ND | ND | ND | 0.05 |
| Dibromochloropropane | ND | ND | ND | ND | ND | ND | ND | 0.2 |
| 2,4,-D | ND | ND | ND | ND | ND | ND | ND | 50 |
| Perchlorate | ND | ND | ND | ND | ND | ND | ND | SNS |
| Alachor | ND | ND | ND | ND | ND | ND | ND | 2 |
| Simazine | ND | ND | ND | ND | ND | ND | ND | 50 |
| Atrazine | ND | ND | ND | ND | ND | ND | ND | 3 |
| Metolachor | ND | ND | ND | ND | ND | ND | ND | 50 |
| Metribuzin | ND | ND | ND | ND | ND | ND | ND | 50 |
| Butachlor | ND | ND | ND | ND | ND | ND | ND | 50 |
| Propachlor | ND | ND | ND | ND | ND | ND | ND | 50 |

Notes:
See Chapter 7, Figure 7-5 for well locations.
For compliance determination with New York State Department of Health standards, potable water samples were analyzed quarterly during the year 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 standards.
< MDL = Less than the minimum detection limit for the analyte in question
ND = Not detected at the minimum detection limit
SNS = Drinking water standard not specified
NYS DWS = New York State Drinking Water Standard
WTP = Water Treatment Plant
[a] The water obtained from Wells 4, 6, and 7 is treated at the WTP prior to site distribution. The concentration of 1,1,1-trichloroethane in the WTP effluent met all drinking water standards.

hazardous substances (i.e., cross-connections). Such practices include the implementation of a rigorous cross-connection control program. Cross-connection control is the preferred method of protecting a public water system and includes the installation of cross-connection control devices at the interface between a facility and the domestic water main. Installation of cross-connection control devices is required at all facilities where hazardous materials are used in a manner that could result in the introduction of these hazardous substances into the domestic water system, especially under low pressure conditions. In addition, secondary cross-connection controls at the point of use are also recommended to protect users within a specific facility from hazards that might be posed by intrafacility operations.

BNL has installed and maintains over 150 cross-connection control devices at interfaces to the potable water main and secondary control devices at the point of use. All cross-connection control units were tested in 2000. All problems found were corrected, and the devices were retested to ensure proper functioning.

### 3.7.3 UNDERGROUND INJECTION CONTROL

UIC is regulated under the SDWA. UICs at BNL include drywells, cesspools, septic tanks, and leaching fields, all of which are classified by EPA as Class V injection wells. Proper management of UIC devices is key to the protection of underground sources of drinking water. In New York State, the UIC program is implemented through EPA, since the NYSDEC did not adopt UIC regulatory requirements (New York regulates discharges

of pollutants to cesspools under the SPDES program). Under the EPA's UIC program, all Class V injection wells must be included in an inventory maintained with the agency.

During 2000, the project to inventory and close unnecessary UICs continued with 43 UICs officially closed between 1999 and 2000. The closure of the UICs included the collection and analysis of bottom sediment samples and submittal of formal documentation to EPA requesting closure authorization. One of the 43 UICs required mitigation of low-level petroleum contamination prior to closure. Additionally, samples collected from septic tanks located at Buildings 1006, 1008, and 1010 were found to have elevated concentrations of metals and/or organics that required remediation prior to their closure. Closures of Building 1006 and 1008 UICs were completed in 2000. The Building 1010 UIC closure is expected to be completed in 2001. The 90 remaining UICs were inventoried and included in the UIC Area Permit application submitted to EPA for approval in September 1999. The UIC Area Permit was issued in January 2001, as discussed in Section 3.2.2.3 of this chapter.

## 3.8 SPILL PREVENTION, EMERGENCY PLANNING, AND REPORTING

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

### 3.8.1 OIL POLLUTION ACT AND SPILL PREVENTION CONTROL AND COUNTERMEASURES (SPCC) PLAN

The Laboratory must maintain a 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 the design of storage facilities, release prevention measures, and maps detailing the location of all storage facilities. The SPCC Plan is filed with NYSDEC, EPA, and DOE. The plan is updated triennially and was last updated in December 2000 (Chaloupka 2000b). BNL remained in full compliance with the SPCC requirements in 2000.

BNL also maintains a facility response plan that outlines emergency response procedures implemented in the event of a worst-case discharge of oil. The EPA reviewed this plan in 2000 and identified several technical deficiencies and formatting issues. Response to the deficiencies was handled in two phases. Phase I addressed simple changes to the plan, including providing cross-referencing to address format issues and updating outdated information. Phase II was a complete plan update that was submitted to EPA in December as part of the SPCC Plan.

### 3.8.2 EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT (EPCRA) AND THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) TITLE III REPORTING REQUIREMENTS

The Emergency Planning and Community Right-to-Know Act (EPCRA) (42 USC 11001) and Title III of the Superfund Amendments and Reauthorization Act (SARA), require reporting of inventories and releases of certain chemicals that exceed specific storage 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. BNL fully complied with these requirements in 2000 through the submittal of the required reports under EPCRA Sections 302-303, 311-312. During 2000, the Part 313 Toxic Release Inventory thresholds were significantly lowered from 10,000 (4,500 kg) to 10 pounds (4.5 kg) for mercury and polychlorinated biphenyls (PCBs). Consequently, reporting for these two classes of chemicals is required for 2000. In total, 21 pounds (9.5 kg) of mercury and 917 pounds (412.7 kg) of PCBs will be reported under the Form R Toxic

**Applicability of EPCRA to BNL**

| | | | | |
|---|---|---|---|---|
| 302-303: | Planning Notification | Yes[X] | No[ ] | Not Required [ ] |
| 304: | EHS Release Notification | Yes[ ] | No[ ] | Not Required [X] |
| 311-312: | MSDS/Chemical Inventory | Yes[X] | No[ ] | Not Required [ ] |
| 313: | TRI Reporting | Yes[X] | No[ ] | Not Required [ ] |

Release Inventory report which will be submitted by July 1, 2001.

There were no releases of extremely hazardous substances reported under Part 304 during 2000.

### 3.8.3 SPILL RESPONSE, REPORTABLE RELEASES, AND OCCURRENCES

When a spill of hazardous material occurs, BNL personnel are required to immediately notify the onsite Fire Rescue Group who 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 its reportability. Any release of petroleum products to soils or surface water is reportable to both NYSDEC and SCDHS. In addition, releases of petroleum products greater than 5 gallons (18.9 liters) to outdoor impermeable surfaces or containment areas are also reported. Spills of chemicals in quantities greater than CERCLA reportable quantities are reportable to the National Response Center, NYSDEC, and SCDHS. Remediation of the spill is conducted as necessary to restore the site. For example, if a piece of heavy equipment ruptured a hydraulic line, resulting in a release of hydraulic oil to the soil, immediate actions would be taken to stop the leak, and then the contaminated soil would be excavated and containerized for offsite disposal.

During 2000, there were 57 spills, of which only 16 met external agency reporting criteria. Ten of the reportable releases involved very small volumes of petroleum that reached soils. New York State has a zero tolerance level for releases of oils to soil or water; consequently, spills of just an ounce to soil is reportable. Seven of the ten reported releases resulted from failed hydraulics on heavy equipment or lawn mowers. To prevent future releases, a pollution prevention project was initiated to replace petroleum oils with vegetable-based oils in several of these machines and to replace standard hydraulic hoses with braided stainless steel hoses. The remaining spills were either small volume releases to soil, or releases to containment areas. There were four larger oil spills reported during 2000 that were more than 50 gallons (189.3 liters) each. These included two releases to containment areas (Buildings 1005 and 479) and one release to the floor of Building 912. The last spill was the discovery of non-PCB oil under a tank located near Building 750. This tank was installed in 1965 as an emergency holding tank for reactor secondary cooling water. The oil was purposely added to the soil to prevent corrosion to the underside of the tank. The remaining two spills involved the release of photodeveloper at Building 197 and the release of 8 pounds (3.6 kg) of mercury from a gauge removed from the former Brookhaven Graphite Research Reactor Instrument House. All spills were remediated or otherwise addressed to the satisfaction of NYSDEC; all contaminated residuals were collected, containerized, and disposed.

Table 3-7 provides information on the reportable spills including the date of the spill, material involved, and quantity released. It also includes a summary of the cause and corrective actions taken, and notes whether the spill was reportable to DOE through the Occurrence Reporting and Processing System (ORPS).

In addition to the four chemical or oil spills noted in Table 3-7 as reported through ORPS, there were ten other incidents that were environmental in nature reported to DOE through ORPS. These included:

- Discovery of four groundwater contaminant plumes from various Laboratory facilities. Two of these involved radiological constituents found at the Alternate Gradient Synchrotron facility. The other two plumes involved the detection of volatile organic compounds: one at the public service station and one at Building 830. See Table 3-8 for a description of each.
- Two incidents were related to the handling of hazardous wastes. The first was the incomplete characterization of soils shipped for disposal at Envirocare of Utah, and the second was the issuance of a Notice of Violation for concerns identified during the 2000 annual hazardous waste inspection by the New York State Department of Environmental Conservation.
- Two incidents involved storage of wastewater in tanker trailers containing low levels of radiological contaminants.

**Table 3-7. Summary of Chemical and Oil Spill Reports (CY 2000).**

| BNL Spill Number | Date | Material | Quantity | Report* | Source/Cause and Corrective Actions |
|---|---|---|---|---|---|
| 00-06 | 2/11/00 | Compressor Oil | ≈100 gallons | No | Mechanical failure of a helium compressor oil pump bearing resulted in the release of oil to an area immediately below compressor skid unit in Bldg. 1005H. Spill was contained to immediate area by concrete lip. |
| 00-09 | 3/7/00 | Motor Oil | < 4 quarts | No | Due to an apparent rupture of the oil filter on a private car, oil spilled onto pavement and soil. Speedi-Dri™ was used to absorb the oil from the pavement. Impacted soil was removed and containerized for offsite disposal along with other spill residuals. |
| 00-14 | 4/11/00 | Mercury | ≈ 8 pounds | Yes CH-BH-BNL-BNL-2000-0008 | Mercury was spotted leaking from a salvage dumpster near Bldg. 704 when a scrap metal vendor attempted to load the dumpster for transit. The mercury leaked from a differential pressure sensor on one of two instruments that had been removed from Bldg. 708 Instrument House and placed in the dumpster for disposal. A metal powder was applied to small pools of mercury that had accumulated on the asphalt pavement outside the dumpster to form an amalgam that was subsequently recovered using a mercury vacuum. The instruments associated with the spill were removed from the dumpster and the mercury within was drained. Beads of mercury on the floor of the dumpster were also recovered with the mercury vacuum. All recovered wastes, including the two instruments, were containerized for offsite disposal. |
| 00-16 | 4/27/00 | Hydraulic Fluid | 2 pints | No | A hydraulic line broke on a lawn mower on the lawn east of Bldg. 750. Site Maintenance repaired the mower, and the soil was removed and containerized for offsite disposal. |
| 00-18 | 5/5/00 | Hydraulic Fluid | 2-3 quarts | No | While mowing the grass area adjacent to Bldg. 750 (HFBR) cooling tower, a hydraulic hose broke spraying oil, which was under pressure. The operator immediately noticed it and drove the mower to the asphalt and parked the vehicle. Spill pads, Speedi-Dri™,and a 5-gallon bucket were used to minimize additional leakage. Impacted grass and soil were excavated and containerized for offsite disposal. |
| 00-22 | 5/16/00 | Hydraulic Fluid | < 1 pint | No | While driving the lawnmower down Rochester Street, the operator noticed a sudden spray of oil from the engine. The operator immediately pulled the vehicle off the road. Upon inspection, a pinhole leak was identified in a hydraulic hose. Fire/Rescue responded and placed Speedi-Dri™ on the material that had spilled on the road. An absorbent pad and a drip pan were placed under the broken line to catch any additional drips. Impacted soils and other spill residuals were excavated and containerized for offsite disposal. |
| 00-25 | 6/8/00 | Hydraulic Fluid | < 5 gallons | No | While mowing the field behind Bldg. 599, a hydraulic line disconnected resulting in a release of fluid to the grass. The hose was repaired and a sod-cutter used to recover oil-contaminated soils. |
| 00-30 | 7/15/00 | Hydraulic Fluid | ≈ 2 gallons | No | Hydraulic fluid leaked to the ground when a hydraulic line on a backhoe failed. A pan was placed under the vehicle until it was removed for repair. Contaminated soil was excavated and placed into a 55-gallon drum for offsite disposal. Oil collected in the drip pan was appropriately disposed. |
| 00-32 | 7/15/00 | Compressor Oil | < 1 gallon | Yes CH-BH-BNL-BNL-2000-0015 | Compressor oil leaked onto the basement floor of Bldg. 901 West when a water-cooled air compressor overheated. Some oil discharged from the compressor found its way into an open floor drain in the room that discharged to the BNL STP. A pump was used to recover about one quart of oil caught in the floor drain trap. Spill absorbents were used to remediate the spill. There was no impact to the STP. |

*(continued on next page)*

**Table 3-7. Summary of Chemical and Oil Spill Reports (CY 2000)** *(concluded)*.

| BNL Spill Number | Date | Material | Quantity | ORPS Report* | Source/Cause and Corrective Actions |
|---|---|---|---|---|---|
| 00-33 | 7/16/00 | Compressor Oil | ≈ 7 gallons | No | Compressor oil leaked onto the floor from a helium compressor stored in Bldg. 919. Apparently, the oil began leaking when personnel working in the area accidentally dislodged a ¼-inch hydraulic line. Fire Rescue personnel responded and used absorbent pads and Speedi-Dri™ to recover the spilled product. Contaminated absorbent materials were placed in a 55-gallon drum for offsite disposal. |
| 00-34 | 7/27/00 | Machine Oil | 62 gallons | Yes CH-BH-BNL-BNL-2000-0017 | During inspection of an access sump for the 70" Vertical Turret Lathe, oil was found. Sixty-two gallons of oil were recovered from the sump. Spill absorbents were used to remove all traces of residual oil. All collected oil and spill absorbents were containerized for offsite disposal. |
| 00-47 | 10/10/00 | Hydraulic Fluid | < 1 pint | No | A contractor was operating an excavator to demolish the HFBR cooling towers when BNL staff noticed a hydraulic line leaking fluid. Most of the oil was contained within a low spot on the equipment but a small volume (described as a few drops) contacted soil. The equipment was stopped and moved onto the pavement. The spill was cleaned up with Speedi-Dri™ and placed into a container. The contractor took ownership of the spill cleanup waste for disposal. |
| 00-48 | 10/11/00 | Oil | Not Determined | No | HFBR aboveground storage tank FA-310 was demolished during the week of October 9, 2000. As anticipated, oil-impregnated soil was found under the base of the tank. In the 1960s, oil was mixed into the soil as a standard construction practice to prevent corrosion to the underside of the steel tank bottom. Removal of the contaminated soils will be completed in 2001. |
| 00-49 | 10/17/00 | Photodeveloper | < 1 gallon | Yes CH-BH-BNL-BNL-2000-0022 | The waste transfer line used to transport spent photographic fixer solution from inside Bldg. 197 to the outdoor haz-store shed (portable Bldg. 791) clogged, forcing waste solution out a line vent on the side of Bldg. 197. Solution spilled to the asphalt surface below and on a small patch of soil. Speedi-Dri™ was applied to affected the area and collected by the Fire/Rescue Group for proper disposal. |
| 00-51 | 11/1/00 | Hydraulic Fluid | < 1 gallon | No | A hydraulic line on a front-end loader ruptured, resulting in a release of approximately 1 gallon of hydraulic fluid to the ground. Plant Engineering recovered and containerized all impacted soils. |
| 00-55 | 12/18/00 | Transformer Oil | 50 gallons | No | A compression fitting failed on a line leading from a high voltage transformer oil surge tank in Bldg. 912. The spill was cleaned up using absorbent pads and the contaminated absorbents shipped for offsite disposal. |

*ORPS Report: Release is reportable to the U.S. Department of Energy under the requirements of DOE Order 232.1A, Occurrence Reporting and Processing of Operations Information.

- One incident involved a spontaneous fire at a CERCLA waste staging area caused by interaction of chemicals removed from former chemical burial sites.
- One incident involved a waste storage tank that overflowed into secondary containment at Building 801 due to a faucet that was left open.

Table 3-8 provides a description for each occurrence. All incidents were addressed through the identification and implementation of corrective actions geared towards the root cause. The groundwater incidents are discussed in further detail in Chapter 7. There were no offsite environmental consequences arising from the ORPS incidents.

#### 3.8.4 MAJOR PETROLEUM FACILITY (MPF) LICENSE

The storage of 2.3 million gallons (8.7 million liters) of petroleum products (principally No. 6 fuel oil) subjects BNL to licensing by NYSDEC. BNL maintains a Major Petro-

leum Facility License for the storage and transfer of oil at the Central Steam Facility. During 2000, BNL remained in full compliance with license requirements. The license requires BNL to monitor groundwater in the vicinity of the seven active aboveground storage tanks that range in size from 60,000 to 600,000 gallons (227,000 to 2,270,000 liters). The license also requires that BNL conduct monthly inspections of storage facilities including testing leak detection and high level monitoring systems, testing secondary containment systems, and periodic inspections of tank integrity. Groundwater monitoring consists of monthly checks for floating products, and twice-yearly tests for semivolatile organic compounds. In 2000, no contaminants or floating products were found in groundwater wells that monitor the MPF. (See Chapter 7 for additional information on groundwater monitoring results.)

Due to scheduling conflicts, an inspection of this facility was not conducted by NYSDEC in 2000, but was performed in January 2001. The inspection noted two conditions that required immediate corrective actions and three conditions requiring corrective actions prior to pending operations. The two conditions requiring immediate action were performance testing of the impressed current cathodic protection system, and inspection of "tell-tales" on Tanks 9 and 10. Tell-tales are access ports installed in the interstitial space of the tank bottoms (these tanks have two bottom layers of steel to prevent leakage to the environment). Both corrective actions were completed within 30 days of the date of inspection. Two of the three remaining corrective actions must be completed prior to returning Tanks 5 and 6 to service. These are the repair of piping and the installation of color-coding at the fill ports. Color-coding of the fill ports was completed within seven days of the inspection. Piping upgrades are expected to be completed by December 2001. The last action was a reminder that in-depth integrity testing of the secondary containment liners is due in June 2001.

### 3.8.5 CHEMICAL BULK STORAGE

All underground tanks, and all aboveground tanks larger than 185 gallons (700.3 liters) that store specific chemical substances listed in 6 NYCRR 597, must be registered with NYSDEC. BNL holds a Hazardous Substance Bulk Storage Registration Certificate. In total, BNL has 18 registered tanks: 17 aboveground tanks storing water treatment chemicals (for cooling towers, wastewater, or potable water treatment) and one for storing gallium trichloride used in neutrino experiments. The tanks range in size from 475 to 2,000 gallons (1,800 to 7,600 liters). During 2000, three tanks storing cooling water treatment reagents at the High Flux Beam Reactor were drained and will be placed into a "permanently out of service" status until they are removed.

### 3.8.6 SUFFOLK COUNTY SANITARY CODE ARTICLE 12

Article 12 of the Suffolk County Sanitary Code, administered by the SCDHS, regulates the storage and handling of toxic and hazardous materials in above or underground storage tanks, drum storage facilities, piping systems, and transfer areas (i.e., storage facilities). It specifies design criteria to prevent environmental impacts resulting from spills or leaks. It also specifies administrative requirements, such as labeling for identification purposes, registration, and spill reporting procedures. In 1987, BNL entered into a voluntary Memorandum of Agreement with the SCDHS in which DOE and BNL agreed to conform to the environmental requirements of Article 12.

BNL has 526 active and more than 300 inactive storage facilities listed in the Suffolk county tanks database. Another 48 storage facilities associated with environmental restoration activities conducted under the CERCLA program that are not regulated under Article 12 are included in the county database. BNL storage facilities listed in the database include those storing fuel (some of which are also regulated under the MPF license), wastewater, chemicals, and those used in support of laboratory research.

At of the end of 2000, 131 of the active tanks listed in the Suffolk County database fully conformed with all Article 12 administrative, maintenance, and technical requirements. Approximately 395 active tanks require administrative corrective actions (e.g., corrected registrations, submittal of as-built design plans to SCDHS, proper labeling, etc.) or maintenance (e.g., replacement of light bulbs). Less than one-quarter of these facilities were found to be in technical nonconfor-

**Table 3-8. Summary of Other Environmental Occurrence Reports (CY 2000).**

| ORPS* ID | Date of Occurrence | Occurrence Description | Status |
|---|---|---|---|
| CH-BH-BNL-BNL-2000-0002 | 1/27/00 | Soils removed during the chemical/glass holes project were disposed of by Envirocare of Utah. Prior to shipping, the waste was characterized for chemical and radiological content. However, analysis performed by Envirocare did not corroborate data supplied by BNL. A full evaluation of waste characterization procedures and verification of waste determination was conducted. | Closed: All corrective actions have been completed. |
| CH-BH-BNL-AGS-2000-0001 | 2/9/00 | An expanded Geoprobe™ survey of a former beam catcher (E-20) located at the AGS confirmed impacts to groundwater from activated soils. Tritium and sodium-22 were found at concentrations two times greater than drinking water standards. Corrective actions included construction of a cap over the affected soils and installation of permanent monitoring wells down stream of the catcher. | Closed: All corrective actions have been completed. |
| CH-BH-BNL-BNL-2000-0005 | 3/11/00 | A fire occurred at the waste staging area for the chemical/glass holes project. It is speculated that straw that was intermixed with shredded waste ignited due to increased biodegradation of the waste during a warm day. The polyethylene sacks holding the waste were consumed in the fire. A hazard assessment was performed of remaining debris and corrective measures were implemented to prevent recurrence. | Closed: All corrective actions have been completed. |
| CH-BH-BNL-AGS-2000-0003 | 4/11/00 | During continued evaluation of potential source areas at the AGS, Geoprobes™ installed at the former U-line beam stop identified tritium concentrations two times greater than drinking water standards. The area was capped to prevent further migration of contaminants to groundwater and permanent monitoring wells installed to monitor the facility. | Closed: All corrective actions have been completed. |
| CH-BH-BNL-BNL-2000-0010 | 4/25/00 | While a tanker trailer was being used for consolidation of wastewater generated during groundwater investigation activities, dunnage was placed beneath the front jacks of the trailer for support. After approximately 40% of the trailer was filled, the jack stands had shifted forward approximately 4 inches, offsetting the load on the dunnage. There were no releases or other accidents resulting from this incident. A Lessons Learned was prepared and field engineers instructed in the findings of this occurrence. | Closed: All corrective actions have been completed. |
| CH-BH-BNL-BNL-2000-0012 | 6/16/00 | During routine monitoring of wells located downgradient of the public service station (Bldg. 630), petroleum hydrocarbons were detected in groundwater. The source of these contaminants is apparently historical operations. An investigation was conducted to ensure that current operations were not contributing to the detection of contaminants in groundwater. | Open: While the ORPS report has been accepted by DOE, there are several corrective actions that remain open. These will be completed in accordance with a preestablished schedule. All milestones have been met. |
| CH-BH-BNL-BNL-2000-0014 | 6/30/00 | A Notice of Violation was issued by NYSDEC for deficiencies in hazardous waste management practices identified during the 2000 annual hazardous waste compliance inspection. Since most deficiencies were administrative, they were immediately corrected during the inspection. A critique was held to prevent recurrence. | Closed: All corrective actions have been completed. |
| CH-BH-BNL-BNL-2000-0018 | 8/11/00 | During a routine survey of the D-waste tanks (wastewater containing low-levels of radioactivity) in Bldg. 801, technicians noted that one of the tanks had overflowed onto the floor. The cause was attributed to a custodian faucet that drained to the D-waste system that was left running. A spring loaded valve was installed to automatically shut the water off. | Closed: All corrective actions have been completed. |
| CH-BH-BNL-BNL-2000-0020 | 8/29/00 | While moving a tanker trailer containing tritiated wastewater, a technician noticed water splashing from the top access hatch. Closer inspection showed that the hatch had not been secured and was not checked before moving the tanker. Water that reached the pavement evaporated and any residual wiped from the truck exterior and the truck decontaminated. The tanker trailer was enroute to an offsite treatment facility. Procedures were established to ensure that all tankers are secured prior to movement. | Closed: All corrective actions have been completed. |
| CH-BH-BNL-BNL-2000-0027 | 12/7/00 | Volatile organic compounds were detected in monitoring wells downgradient of Bldg. 830. While the monitoring wells have been sampled since 1989, volatile organic compounds were not detected. During 2000, significant changes to groundwater movement in this area resulted from changes in potable water use. It is speculated that the changes in flow direction are responsible for the recent detection of VOCs in this well. An investigation is underway to ensure that current facility operations are not contributing to this finding. Geoprobe™ wells will be installed to verify the source. | Open: Full characterization of the groundwater plume is ongoing and an investigation into possible sources is ongoing. The investigation is progressing under a preestablished schedule. |

*ORPS Report: Release is reportable to the U.S. Department of Energy under the requirements of DOE Order 232.1A, Occurrence Reporting and Processing of Operations Information.

mance with Article 12 requirements (e.g., no secondary containment, no high-level detection). BNL has an ongoing program to upgrade and/or replace existing storage facilities. In 2000, BNL established a project plan to achieve full conformance with Article 12 requirements. The project will provide administrative and technical improvements to approximately 115 active storage facilities. Other upgrades are being addressed through labeling and filing of addendums to the BNL tank inventory (i.e., filing tank registrations), which will continue through 2003.

### 3.9 RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

The Resource Conservation and Recovery Act (RCRA) regulates hazardous wastes that could present risks to human health or the environment if mismanaged. The regulations are designed to ensure that hazardous wastes are managed from "cradle to grave," that is, from the point of generation to final disposal. In New York State, the RCRA program is delegated to NYSDEC by EPA, but EPA retains an oversight role. BNL is considered a large quantity generator and has a RCRA permit to store hazardous wastes for one year prior to offsite shipment for treatment and disposal. As noted in Chapter 2, BNL has a number of 90-day storage and satellite accumulation areas.

On June 14, 2000, the NYSDEC conducted its annual inspection of the BNL hazardous waste management operations. The NYSDEC issued a notice of violation for seven administrative deficiencies identified during the course of the inspection. Five were immediately corrected before the end of the inspection. The remaining two issues concerned the placement of a waste accumulation area and quality control sampling in accordance with BNL's *Waste Analysis Plan*. Documentation was provided confirming that BNL had addressed all dificiencies noted to the satisfaction of the NYSDEC.

#### 3.9.1 FEDERAL FACILITIES COMPLIANCE ACT (FFCA) SITE TREATMENT PLAN FOR MIXED WASTE

Mixed wastes are considered both hazardous (under RCRA) and radioactive. The FFCA, issued in 1992, requires DOE to work with local regulators to develop a site treatment plan to manage mixed waste. Development of the plan has two purposes: (1) to identify available treatment technologies and disposal facilities (DOE or commercial) able to manage mixed waste produced at federal facilities, and (2) to develop a schedule for treatment and disposal of these waste streams.

BNL updates its Site Treatment Plan for mixed wastes (BNL 1997) annually and submits it to the NYSDEC. The update 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 most of the mixed waste currently in storage have been identified, and most of the current inventory will be shipped offsite for treatment and disposal in 2001. BNL will continue to update the treatment plan for wastes with no identified disposal pathway.

### 3.10 TOXIC SUBSTANCE CONTROL ACT (TSCA)

The storage, handling, and use of PCBs (Polychlorinated Biphenyls) are regulated under the Toxic Substances Control Act (TSCA). Capacitors manufactured prior to 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 manufacturer's records. All equipment containing PCBs must be inventoried, with the exception of small capacitors (less than 3 pounds [1.35 kg]) and items where the concentration of the PCB source material is less than 50 parts per million. This inventory is updated by July 1 of each year. All PCB-containing articles and/or PCB-contaminated equipment must be labeled. BNL responds to any PCB spill in accordance with emergency response procedures. BNL was in compliance with TSCA requirements in 2000. The Laboratory's authorization from EPA to conduct research using PCBs expired on July 31, 2000. The one research project involving PCBs was discontinued, and was reported to EPA. No PCB research was conducted at BNL in 2000.

### 3.11 FEDERAL INSECTICIDE FUNGICIDE AND RODENTICIDE ACT (FIFRA)

The storage and application of pesticides (insecticides, rodenticides, herbicides, algicides, etc.) is 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 onsite. Herbicide use is minimized wherever possible (e.g., through spot treatment of weeds). All pesticides are applied by Laboratory-employed New York State-certified applicators. By February 1, each applicator files an annual report with NYSDEC detailing insecticide/herbicide use for the previous year.

BNL is in full compliance with FIFRA requirements. In 2000, BNL initiated an integrated pest management review of herbicide and insecticide application practices. In cooperation with the Cornell Cooperative Extension Service, the Laboratory is evaluating opportunities to further reduce pesticide use. Integrated pest management seeks to minimize the application of pesticides by the use of improved prevention and inspection techniques for pest identification rather than broad application, and by the use of reduced-risk pesticides. The review will be completed in the summer of 2001.

### 3.12 FLOODPLAINS/WETLANDS AND WILD, SCENIC, AND RECREATIONAL RIVERS AND OTHER SPECIAL 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 as either scenic or recreational under the Wild, Scenic, and Recreational River System Act by NYSDEC. BNL also has six areas regulated as wetlands and a number of vernal (seasonal) pools onsite. Construction and/or modification activities performed within these areas require permits from the NYSDEC.

Activities that could require review under the natural resource protection program, including floodplain/wetland review requirements, 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 impact 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.

Two activities continued in 2000 that required special permits. The first project was construction of a security fence and improvements to a perimeter road at the RHIC facility. The second project was construction of pumping stations and extension of sanitary mains throughout the RHIC facility. Both projects involved crossing the Peconic River in at least one location. The fencing project was completed in June 2000. The sewer extension project is still in progress and is expected to be completed by the end of 2001.

### 3.13 ENDANGERED SPECIES ACT

In 1999, NYSDEC revised its list of endangered, threatened, and "species of special concern." The tiger salamander (*Ambystoma t. tigrinum*) is the only state endangered species found at BNL. 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 bait and pet trade, water level fluctuations, pollution, and general disturbance of breeding sites. BNL has prepared a Wildlife Management Plan (Naidu 1998) that formalizes the strategy and actions needed to protect 14 confirmed tiger salamander breeding locations identified onsite. The strategy includes identifying and mapping habitats, monitoring breeding conditions, improving breeding sites, and controlling activities that could negatively impact breeding.

The banded sunfish (*Enneacanthus obesus*) and swamp darter (*Etheostoma fusiforme*) are found in the Peconic River drainage areas onsite at BNL. Both are listed as state threatened species within New York State. The reason for this status is that the only remaining populations of these fish in New York are on eastern Long Island. Measures being taken by BNL to protect the banded sunfish and swamp darter and their habitat include:

- eliminating, reducing, or controlling pollutant discharges,
- upgrading the STP to reduce nitrogen loading in the Peconic (completed in 1998),

- monitoring populations and water quality,
- maintaining adequate flow in the river to enable the fish to survive drought, and
- controlling disturbances.

BNL also has eight species onsite that are listed as "species of special concern." Species of special concern 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. The species of special concern found at BNL include the marbled salamander (*Ambystoma opacum*), the spotted turtle (*Clemmys guttata*), the eastern box turtle (*Terrapene carolina*), the eastern hognosed snake (*Heterodon platyrhinos*), the horned lark (*Eremophila alpestris*), the whip-poor-will (*Caprimulgus vociferus*), the vesper sparrow (*Pooecetes gramineus*), and the grasshopper sparrow (*Ammodramus savannarum*). Management efforts taken for the 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 onsite. The eastern hognosed snake has only been seen onsite once, in 1994 (LMS 1995). BNL will be evaluating bird populations as part of the management strategy outlined in the Wildlife Management Plan. Data concerning species of special concern will be used appropriately in making management decisions regarding those species. In addition to the above bird species, 19 other bird species listed as species of special concern and two federally threatened species have been observed onsite or flying over the site during spring and fall migrations.

BNL has 17 plant species protected under state law. One is a threatened plant, stiff goldenrod (*Solidago rigida*), and one is a rare plant, narrow-leafed bush clover (*Lespedeza augustifolia*). The other 15 species are considered to be "exploitably vulnerable," which means that they may become threatened or endangered if causal factors resulting in population declines continue. These plants are currently protected at BNL due to the large areas of undeveloped pine barren habitat onsite. Locations of these rare plants must be determined, populations estimated, and management requirements established. Management of protected plants will be included in the future revisions of the Wildlife Management Plan. See Chapter 6 for more information.

### 3.14 EXTERNAL AUDITS AND OVERSIGHT

A number of federal, state, and local agencies oversee BNL activities. BNL was inspected by federal, state, or local regulators on at least 13 occasions in 2000. These inspections are summarized below. Since 1998, the SCDHS has had two full-time staff members stationed at BNL. They perform routine inspections of facilities and inspect storage facility removals and installations as part of their everyday activities. In addition to external audits and oversight, BNL has a comprehensive self-assessment program as described in Section 2.1.7 of Chapter 2.

#### 3.14.1 INSPECTIONS BY REGULATORY AGENCIES

- *Hazardous Waste*. NYSDEC conducted a RCRA/hazardous waste compliance inspection in June 2000. See Section 3.9 for information regarding this inspection.
- *Air Compliance*. NYSDEC conducted an annual inspection of the Central Steam Facility in February 2000. No findings or issues were identified during this inspection. In January 2000, EPA Region II performed a site inspection to evaluate the status of NESHAPs compliance. Areas inspected included facilities at the AGS, RHIC, the BGRR Decommissioning Project, and the Sewage Treatment Plant. The inspection identified the need to perform a NESHAPs evaluation on the sand filter beds at the Sewage Treatment Plant. This evaluation has been completed.
- *Potable Water*. SCDHS conducts annual inspections of the BNL potable water system to collect samples and ensure that facilities are maintained. There were no findings in 2000. All sample results were within drinking water standards, except for iron, which is naturally occurring. As noted in Section 3.7.1, BNL treats the drinking water supply to remove iron prior to consumption.
- *Sewage Treatment Plant (STP)*. SCDHS conducts quarterly inspections of the BNL STP. In 2000, no performance or operational issues were identified during these inspections.

- *Recharge Basins.* As part of SCDHS oversight, quarterly inspections of recharge basins and other SPDES outfalls are conducted by the SCDHS. In 2000, four inspections were conducted. While there were no SPDES issues identified during these inspections, a concern over soil quality at Outfall 005 was raised. Screening for PCBs showed all levels to be less than EPA action levels for soils.
- *Major Petroleum Facility (MPF).* The MPF is inspected annually by NYSDEC. This inspection was conducted in January 2001. See Section 3.8.4 for a discussion of this inspection.

### 3.14.2 INSPECTIONS BY DEPARTMENT OF ENERGY: HEADQUARTERS, CHICAGO AND BROOKHAVEN AREA OFFICE

*DOE Headquarters*

DOE Headquarters conducted a review of the Laboratory's overall performance in 2000 as part of a condition contained in the BSA-DOE contract. This review consisted of evaluation of a number of environmental metrics, including the amount of waste produced, number of SPDES permit excursions, releases, etc. The Laboratory exceeded the expectations established by DOE. See Chapter 2 for more information.

*DOE Chicago Operations Office*

In May 2000, the DOE Chicago Operations Office conducted a verification of BNL's Integrated Safety Management System (ISMS). This comprehensive assessment verified the adequacy of BNL's ISMS in fulfilling the requirements of DOE Policy 450.4 (1996), *Safety Management System Policy* and Department of Energy Acquisition Regulation 970.5204-2 (DEAR 1997), *Integration of Environment, Safety, and Health into Work Planning and Execution*. BNL was the first multi-program Laboratory to achieve verification of ISM with no deficiencies.

Noteworthy practices identified in the verification report [DOE 2000] and the ISMS approval letter included the following:

- The Laboratory's program for clear assignment of Roles, Responsibilities, Accountabilities, and Authorities (R2A2). This program facilitates awareness responsibilities related to Environment, Safety, and Health (ES&H) activities. The R2A2 program also defines the basis to set employee performance goals and measures.
- Demonstrated strong commitment and leadership by BNL senior management to work in a formally agreed-upon partnership with DOE to achieve a shared vision, critical outcomes, performance goals, and objectives and achieve excellence in implementing a mature ISMS.
- The Laboratory's Standards Based Management System (SBMS). The SBMS is a web-based document management system that provides the means to deliver Laboratory policies and procedures. It ensures easy access for Laboratory personnel as well as the interested public.
- The Laboratory's Environmental Management System (EMS). BNL's EMS conforms to ISO 14001 standards, with added emphasis on compliance assurance, community outreach, and pollution prevention. At the time of the verification, BNL had achieved ISO 14001 registration of the RHIC project and was on schedule for registration of other major Laboratory facilities. (Note: Since the ISMS verification, the ISO 14001 registration has been achieved for the major facilities.)

*DOE Brookhaven Area Office*

The DOE Brookhaven Area Office continued to strengthen their oversight program during 2000 and conducted compliance assessments on lead safety, affirmative procurement, and a review of the environmental subject area regulatory drivers. Several concerns, and areas for improvement were identified during these assessments. Corrective action plans were prepared and are being implemented to address all issues.

### 3.14.3 ENFORCEMENT ACTIONS AND MOAs

No new consent orders were issued to BNL in 2000. A notice of violation was issued by NYSDEC as a result of the annual RCRA inspection (see discussion in Section 3.9). EPA and DOE signed a voluntary MOA on March 23, 1998, which is discussed in Chapter 2. During 2000, BNL continued to be in full compliance with the terms of the MOA. All existing enforcement actions and MOAs are listed in Table 3-9, along with a summary of their status. BNL believes that it has fully complied with the terms and conditions listed in these actions and has

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

| Number | Title | Parties | Effective Date | Status |
|---|---|---|---|---|
| **Enforcement** | | | | |
| Not Applicable | Notice of Noncompliance - Toxic Substances Control Act | EPA and DOE | 02/12/98 | All required information was submitted to EPA on 10/6/98. The Waste Management Division implemented a revised Hazardous Waste Control Form in 1999. There was no additional activity regarding this Notice in 2000, and efforts have been taken to close it. |
| Index No. 113-98-01 | Compliance Order - Clean Air Act | EPA and DOE | 02/24/98 (date of receipt by DOE) | BNL, DOE, and EPA met in May 1998 to review and clarify the issues presented in this Order. Documentation necessary to support Laboratory operations was submitted to EPA prior to the issuance of the Order. There has been no further activity since 1998. |
| Docket No. UIC-AO-98-01 | Administrative Order on Consent – Safe Drinking Water Act | EPA and DOE | 03/4/98 | This Order was finalized in September 1999. All corrective measures were completed by September 30, 1999, and a draft permit was issued by EPA in August 2000. Upon issuance of the finalized permit, the order was terminated. |
| CI-8975-03-99 | Letter of Complaint | NYSDEC and BNL | 03/24/99 | NYSDEC cited BNL two administrative and one technical noncompliances with hazardous waste regulations. Specifically, late submittal of a closure certificate for the former Hazardous Waste Management Facility, a missing land disposal restriction code on a manifest, and the unavailability of a communication device in a 90-day storage area. All deficiencies were corrected and a penalty of $2,250 was paid to NYSDEC in 1999. Official closure of this Letter of Complaint is expected from NYSDEC in early 2001. |
| Not Applicable | Notice of Violation - Resource Conservation and Recovery Act (RCRA) | NYSDEC | 06/14/00 | A Notice of Violation was issued for deficiencies in hazardous waste management practices. These deficiencies were noted during the 2000 annual hazardous waste compliance inspection conducted by the NYSDEC. This NOV was officially closed by NYSDEC in 2000. |
| **Agreements** | | | | |
| Not Applicable | 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 is in conformance with the environmental and technical requirements of Suffolk County codes. |
| Not Applicable | Federal Facilities Compliance Agreement (FFCA) on Mixed Wastes | NYSDEC and DOE | 1992 (Updated Annually) | The 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" on 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, RCRA, and the National Environmental Policy Act. All IAG scheduled milestones were met in 2000. |
| Not Applicable | NYSDEC Stipulated Agreement for NYSDEC Spill No. 96-11117 | NYSDEC and BNL | 12/2/97 | The Laboratory entered into an agreement with the NYSDEC to investigate an unknown source of petroleum contamination on the south side of Building 326 which was discovered during the removal of a propane tank. Monitoring wells were installed and monitored until the spring of 2000 to determine if there were any impacts to groundwater. No impacts were identified and the spill was attributed to historic operations. The NYSDEC concurred with BNL's recommendation to cease monitoring. |
| Not Applicable | Memorandum of Agreement (MOA) By and Between the U.S. Environmental Protection Agency and the U.S. Department of Energy | EPA and DOE | 03/23/98 | BNL is currently in full compliance with the terms of the MOA. See Chapter 2 for further discussion. |

Notes:
EPA = U.S. Environmental Protection Agency
DOE = U.S. Department of Energy
NYSDEC = New York State Department of Conservation
SCDHS = Suffolk County Department of Health Services

**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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Chapter 4

# Air Quality

Brookhaven National Laboratory performs continuous emissions sampling at several facilities to ensure compliance with requirements of the Clean Air Act. In addition to a facility emissions monitoring program, routine environmental air sampling is conducted to verify local air quality and environmental impacts.

In 2000, the Brookhaven Medical Research Reactor, the High Flux Beam Reactor, and the Brookhaven Linear Accelerator Isotope Producer were the most significant contributors to the site's radiological air emissions. Total radionuclide emissions were consistent with those of recent years. During 2000, a total of 3,265 Ci (121 TBq) of airborne radioactive material was released from these facilities. Gaseous argon-41 and oxygen-15 (both short-lived radionuclides with respective half-lives of 1.8 hours and 123 seconds) from the Brookhaven Medical Research Reactor and the Brookhaven Linear Accelerator Isotope Producer respectively accounted for more than 99% of this total.

Due to rising natural gas prices, the Central Steam Facility relied more on residual fuel to meet the heating and cooling needs of BNL's major facilities than in 1999. As a result, annual facility emissions of particulate matter, nitrogen oxides, and sulfur dioxide rose in 2000. Still these pollutant emissions were 32%, 22%, and 59% lower than respective totals in 1996.

## 4.1 RADIOLOGICAL AIRBORNE EMISSIONS

Federal air quality laws and U.S. DOE regulations governing the release of airborne radioactive material include 40 CFR 61 Subpart H (from the National Emission Standards for Hazardous Air Pollutants or NESHAPs), DOE Order 5400.1 (1990), *General Environmental Protection Program*, and DOE Order 5400.5 (1993), *Radiation Protection of the Public and the Environment*. Under NESHAPs Subpart H, a section of the federal Clean Air Act, facilities with emissions that have the potential to deliver a radiation dose of greater than 0.1 mrem/year (1 μSv/year) to a member of the public must be continuously monitored. BNL has five facilities that fall into this category. Figure 4-1 indicates the location of each of the monitored facilities, and Table 4-1 presents the airborne releases from each of these facilities during 2000. Facilities with emissions that fall below this value require only periodic, confirmatory monitoring. Annual emissions are discussed in the following sections. The associated dose calculations are presented in Chapter 8.

### 4.1.1 BROOKHAVEN MEDICAL RESEARCH REACTOR

In August 2000, DOE announced that the Brookhaven Medical Research Reactor (BMRR) would be permanently shut down. Until it stopped operating in late December 2000, the BMRR was fueled with enriched uranium, moderated and cooled by light water, and was operated intermittently at power levels up to 3 MW (thermal). To cool the neutron reflector surrounding the core of the BMRR reactor vessel, air from the interior of the containment building was used. When air was drawn through the reflector, it was exposed to a neutron field that caused the argon component of the air to become radioactive. This radioactive form is known as argon-41. It is an inert

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

**Table 4-1. Airborne Radionuclide Releases from Monitored Facilities (CY 2000).**

| Facility | Nuclide | Half-life | Ci Released |
|---|---|---|---|
| BMRR | Ar-41[(1)] | 1.8 hours | 2.19E+03 |
| HFBR | Cs-137 | 30 years | 1.30E-07 |
| | H-3 | 12.3 years | 4.80E+00 |
| BLIP | O-15 | 122 seconds | 1.07E+03 |
| | H-3 | 12.3 years | 2.46E-04 |
| Evaporator Facility | Be-7 | 53 days | 7.81E-05 |
| | Co-56 | 79 days | 4.91E-07 |
| | Co-57 | 271 days | 4.94E-06 |
| | Co-58 | 71 days | 2.97E-06 |
| | Co-60 | 5.2 years | 3.95E-06 |
| | Cs-137 | 30 years | 8.71E-06 |
| | H-3 | 12.3 years | 3.25E-01 |
| | Mn-54 | 312 days | 3.13E-06 |
| | Na-22 | 2.6 years | 2.21E-07 |
| | Rb-86 | 18.6 days | 1.44E-05 |
| | Se-75 | 120 days | 3.49E-07 |
| | Zn-65 | 244 days | 7.28E-05 |
| Target Processing Laboratory | Cs-137 | 30 years | 7.10E-10 |
| | I-126 | 13 days | 1.17E-12 |
| | Se-75 | 120 days | 8.97E-12 |
| **Total** | | | 3.265E+03 |

Notes:
Ci = 3.7E+10 Bq.
BMRR=Brookhaven Medical Research Reactor
HFBR=High Flux Beam Reactor
BLIP=Brookhaven LINAC Isotope Producer
(1) While other nuclides are released from the BMRR, none contributed >10% of the total public dose due to BMRR air emissions. See text for discussion.

gas with a short half-life of 1.8 hours. After passage through the reflector, the air was routed through a roughing filter and a high efficiency particulate air (HEPA) filter to remove any particulate matter. Charcoal filters were also used for the removal of radioiodines produced during the fission process. Following filtration, the air was exhausted to a 150-foot (46 meter) stack adjacent to the reactor containment building.

A real-time monitor was used to track argon-41 air emissions, while passive filter media were used to collect and quantify radioiodines and particulates. Because non-argon radionuclide concentrations in the air emissions are of a much lower concentration and total activity, they contributed less than 10% of the total public dose resulting from the BMRR's air emissions. In accordance with NESHAPs Subpart H requirements, these radionuclides were sampled on a periodic basis to confirm that their concentrations were within expected levels.

In 2000, the BMRR released 2,190 Ci (81 TBq) of argon-41 to the atmosphere. This value is consistent with previous years emission totals for this facility. Argon-41 has consistently constituted the largest fraction of all radionuclide activity released from the BNL site.

#### 4.1.2 HIGH FLUX BEAM REACTOR

Following the discovery of an underground plume of tritium emanating from the spent fuel storage pool, the High Flux Beam Reactor (HFBR) was kept in a stand-by mode from January 1997 until November 1999, when DOE announced that it would be permanently shut down. The storage pool was drained in December 1997 to prevent additional leakage as well as to facilitate repairs. When the HFBR was operational, it used heavy water as a neutron moderator and fuel coolant. Heavy water, or $D_2O$, is water that is composed of a nonradioactive isotope of hydrogen known as deuterium. When exposed to the neutron fields generated inside the reactor vessel, the deuterium became activated, producing radioactive tritium (half-life = 12.3 years). In a shutdown mode, tritium continues to be released from the HFBR even though the reactor vessel has been de-fueled, because the vessel and associated cooling loops remain filled with heavy water. Tritiated water vapor (abbreviated HTO) is released from the vessel and associated piping systems (via diffusion at valve seals and other system penetrations) to building air, where it is routed to the facility's 328-foot (100-meter) stack. Concentrations of HTO in air emissions are determined by the use of an integrating silica gel absorbent. In 2000, 4.8 Ci (0.2 TBq) of airborne HTO were released from the HFBR. Figure 4-2 illustrates the declining trend of tritium emissions.

#### 4.1.3 BROOKHAVEN LINAC ISOTOPE PRODUCER

Protons from the Linear Accelerator are sent via an underground beam tunnel to the Brookhaven Linac Isotope Producer (BLIP), where they strike various target metals. These metals, which become activated by the proton beam, are then transferred to the Target Processing Laboratory (Bldg. 801) for later use in radiopharmaceutical research. During irradiation, the targets are cooled by a continuously recirculating water system. Several radioisotopes are produced in the cooling water; the most significant of which is gaseous

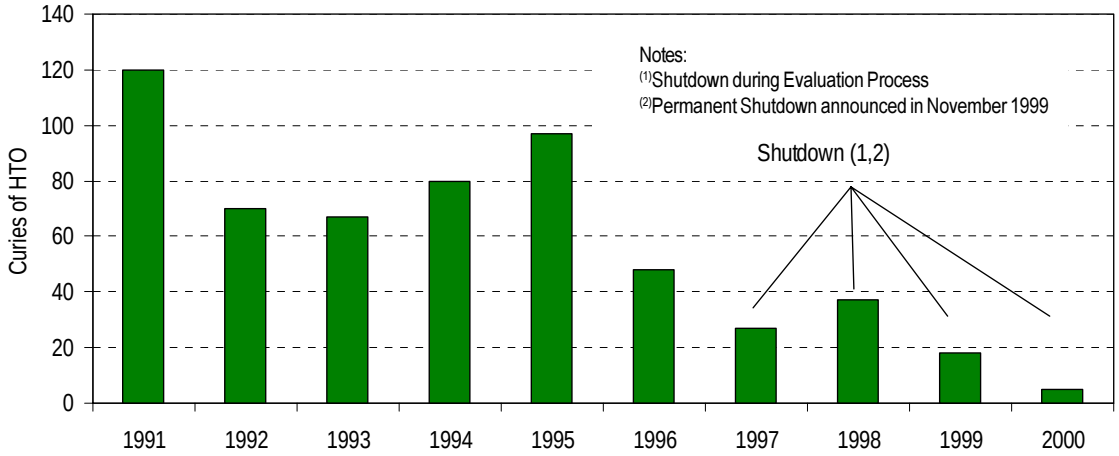


**Figure 4-2. HFBR Airborne Tritium Emissions, Ten Year Trend (1991-2000).**

oxygen-15, a radionuclide with a very short half-life of 122 seconds. This isotope is released as an airborne emission.

In 2000, the operation of the BLIP was limited to the months of January through March. Over this period, a total of 1,070 Ci (39.6 TBq) of oxygen-15 was released as an airborne emission. Tritium was also released, but in a much smaller quantity. See Table 4-1 for a complete listing.

#### 4.1.4 EVAPORATOR FACILITY

The Evaporator Facility (Bldg. 802B) was constructed to reduce the total amount of tritiated water released to the Peconic River from BNL operations. Wastewater processing began in 1995.

Liquid waste generated onsite that contains residual radiological material is accumulated at the Waste Concentration Facility (WCF) in Building 811. At the WCF, suspended solids and a high percentage of radionuclides are removed from the liquid using reverse osmosis. However, because of its chemical properties, tritium cannot be removed. The tritiated water which remains following waste concentration is transferred to the Evaporator Facility in Building 802B, where it is converted to steam and released as an airborne emission. The emissions are directed to the same stack used by the HFBR for building air exhaust. This method is preferable to release via surface water because there is virtually no potential to influence groundwater, and the potential for this tritium to contribute to an offsite dose is minimized by atmospheric dispersion.

In 2000, 0.3 Ci (12 GBq) of HTO were released as an airborne emission from the Evaporator Facility. Since the waste concentration process does not remove all other radionuclides with complete efficiency, radionuclides other than tritium were released at much lower activity levels (see Table 4-1 for a listing). The activity values listed in the table were estimated, since emissions from this facility are tracked using an inventory system. Liquid shipments to the Evaporator Facility were sampled and analyzed prior to delivery to determine actual radionuclide concentrations. The total emissions for a water tanker delivery were calculated by computing the product of the radionuclide concentrations and the total volume of water evaporated. This method is very conservative since some fraction of the chemically reactive radionuclides bind to the interior surfaces of the boiler system; hence, airborne releases and projected doses from this facility are most likely overestimated.

#### 4.1.5 TARGET PROCESSING LABORATORY

Target metals irradiated at the BLIP facility are transported to the Target Processing Laboratory (Building 801) where the useful isotopes are chemically extracted for radiopharmaceutical production. Airborne radionuclides released during the extraction process are drawn through multi-stage HEPA and charcoal filters and then vented to the HFBR stack (see Table 4-1 for isotopes and quantities). Radionuclide quantities released from this facility annually are small, typically in the microcurie range. Isotopes released to the atmosphere from the Target Processing

Laboratory operations are not significant contributors to the site perimeter dose via the airborne pathway (less than 1%).

#### 4.1.6 ADDITIONAL MINOR SOURCES

There are several research departments within BNL conducting work that involves very small quantities of radioactive materials in the microcurie to millicurie range. Typically, fume hoods designated for use with radioactive materials are used. Operations such as transferring material between containers, pipetting, and chemical compound labeling are typical of the work conducted within the hoods. Due to the use of filters, the nature of the work conducted, and the small quantities involved, these operations have a very low potential for atmospheric releases of any environmentally significant quantities of radioactive materials. Compliance with NESHAPs 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, 555, 318, 490, 490A, 703W, and 830, where research in the fields of biology, chemistry, medicine, applied science, and advanced technology is conducted.

#### 4.1.7 PREVIOUSLY UNCHARACTERIZED RADIOLOGICAL AIR EMISSION SOURCES EVALUATED IN 2000

A number of new environmental restoration operations and other key facility processes that produce radiological air emissions were evaluated in 2000. Since all environmental restoration activities covered under the Comprehensive Environmental Response, Compensation and Liability Act must conform to the substantive requirements of NESHAPs Subpart H, those activities with the potential to emit radiological emissions were assessed for dose. The CAP88-PC dose modeling program was used to estimate the maximum dose to members of the public that could be associated with these activities (see Chapter 8 for more information on this modeling program). This modeling program is explicitly designed to model continuous airborne radiological emissions that occur over the course of a single year, and is not well suited for estimating short-term or acute releases such as those found with the environmental restoration activities. Given this limitation, these evaluations tend to be very conservative and overestimate the effective dose equivalent to the maximally exposed individual, since they treat potential emission sources as if they were continuous annual sources that do not end with the cessation of environmental restoration activities. The conclusions of the assessments are discussed below.

##### 4.1.7.1 CHEMICAL/ANIMAL AND GLASS HOLES PITS SOIL EXCAVATION

The chemical/animal pits were used for the disposal of chemical containers, glassware, and animal carcasses from the late 1950s to 1966, while the glass holes pit was used for the disposal of laboratory glassware and chemical containers from 1966 to 1981. The soil in stockpile #6B was generated during the pit excavation phase of the ongoing environmental restoration activities. Stockpile #6B contained approximately 440 cubic yards (336 cubic meters) of soil removed from the bottom of several pits located in the chemical/animal pit area. Because the potential existed for radiologically contaminated soil particles to become airborne during loading and shipping of contaminated soil, a NESHAPs evaluation was conducted.

Using site-specific meteorological data (temperature, precipitation, wind speed, and mixing height), the effective dose equivalent to the maximally exposed individual from these activities was estimated to be 6.07E-03 mrem/year (6.07E-02 μSv/yr) using the CAP88-PC model. This dose to the maximally exposed individual is below the 0.1 mrem/year (1 μSv/yr) threshold that triggers the NESHAPs permitting requirements. Therefore, this soil removal operation was exempt from permitting requirements.

##### 4.1.7.2 WASTE CONCENTRATION FACILITY SOIL EXCAVATION

During the ongoing environmental restoration activities at the Waste Concentration Facility (Bldg. 811), approximately 700 cubic yards (535 cubic meters) of radiologically contaminated soil was excavated in the vicinity of the building. To help prevent soil particles from becoming airborne, water mist was applied to soils during excavation and backfill operations. Following the project health & safety plan, local meteorology was monitored, and work was suspended if

sustained winds exceeded 25 miles per hour (40 km per hour).

The probable release inventory of radionuclides in the soil consisted of cesium-137 (464 pCi/g) and strontium-90 (454 pCi/g). Using the CAP88-PC model, an effective dose equivalent of 8.52E-03 mrem/year (8.52E-02 μSv/yr) to the maximally exposed individual was estimated. This dose to the maximally exposed individual is below the 0.1 mrem/year (1 μSv/yr) threshold that triggers the NESHAPs permitting requirements. Therefore, this soil excavation activity was exempt from permitting requirements.

#### 4.1.7.3 BROOKHAVEN GRAPHITE RESEARCH REACTOR DUCT REMOVAL

The Brookhaven Graphite Research Reactor (BGRR) operated from 1950 to 1969, producing neutrons for scientific research. The BGRR Decommissioning Project, which commenced in 1999, involves removing or isolating areas of the BGRR facility that contain hazardous materials and/or radioactive contamination to reduce any potential risk to the public, workers, and the environment. BGRR environmental restoration activities in 2000 included the partial removal of the aboveground primary air-cooling ductwork that was part of the pile primary air-cooling system. Pile cooling air was ducted towards the top of the fan house in Building 704, where the north and south air plenums joined to form a common header over the fan house. The common header ducted the air to the intake of five fans, which were removed in 1999. The fans discharged air into an underground duct that carried the air to the 328-foot (100-meter) main stack. The internal surfaces of the ductwork were contaminated.

**Figure 4-3. Railcar Loading of Contaminated Landscape Soil.**

Radiological samples were taken from the interior surface of the ductwork to determine the type and quantity of contamination present. A fixative was used to contain any loose contamination, and the duct opening was capped and sealed to prevent any spread of contamination.

Using site-specific meteorological data and current population data, the effective dose equivalent to the maximally exposed individual, estimated with the CAP88-PC model, was 1.5E-05 mrem/year (1.5E-04 μSv/yr). This dose is below the 0.1 mrem/year (1 μSv/yr) threshold that triggers the NESHAPs permitting requirements. Therefore, no permit application was required for this operation.

#### 4.1.7.4 AREA OF CONCERN 16 SOIL REMOVAL ACTION

This environmental restoration removal action involved the excavation of landscape soil contaminated with low levels of cesium-137 in six areas of concern. Contaminated soil was excavated to a depth of 1 foot (0.30 meters). The soil was excavated using both conventional construction equipment and manual tools for narrow and restricted areas. Excavated soil was later packaged and transferred to railcars for offsite disposal (see Figure 4-3).

Using the CAP88-PC model along with site-specific meteorological data and current population data, the effective dose equivalent to the maximally exposed individual was estimated to be 3.66E-02 mrem/year (3.66E-01 μSv/yr). This dose to the maximally exposed individual is below the 0.1 mrem/year (1 μSv/yr) threshold that triggers the NESHAPs permitting requirements. Therefore, no permit application was required for this operation.

#### 4.1.7.5 WASTE MANAGEMENT DIVISION RADIOACTIVE WASTEWATER PROCESSING OPERATIONS

During a process evaluation of radioactive wastewater processing operations associated with the Waste Concentration Facility in Building 811, waste transfer operations in Building 810, and the Evaporator Facility in Building 802B, a recommendation was made to conduct a NESHAPs evaluation of a number of sources that have the potential to

release small amounts of radiological emissions that are not directed to the HFBR stack. Included among the sources evaluated were vent pipes for the four aboveground wastewater storage tanks in Building 811, vent pipes for a 15-gallon (57-liter) condensate storage tank and a 5,000-gallon (18,925-liter) tritiated water tank in Building 802B, and potential fugitive emissions from leaks in pumps and pipe valves in the wastewater transfer lines connecting the three buildings. The potential airborne source term was estimated based on the information provided in the process evaluation and worst-case emission factors from 40 CFR 61, Appendix D.

The CAP88-PC model provided a conservative estimate of the effective dose equivalent to the maximally exposed individual. The 1.76E-03 mrem/year (1.76E-02 μSv/yr) effective dose equivalent from these operations is well under the 0.1 mrem/year (1 μSv/yr) threshold that triggers the NESHAPs permitting requirements.

#### 4.1.7.6 SEWAGE TREATMENT PLANT SOIL AND SEDIMENT EXCAVATION

Since planned excavation of cesium-137 contaminated soil and sediment at the Sewage Treatment Plant would disturb and suspend soil and sediment particles, a NESHAPs evaluation was performed to estimate the potential dose to members of the public. During excavation activities, approximately 3,000 cubic yards (2,294 cubic meters) of soil were removed from the bottom of several filter beds at the Sewage Treatment Plant.

The CAP88-PC modeling program conservatively estimated the effective dose equivalent to the maximally exposed individual to be 5.96 E-02 mrem/year (5.96 E-01 μSv/yr). The effective dose equivalent from this source is well under the 0.1 mrem/year (1 μSv/yr) threshold that triggers NESHAPs Subpart H permitting requirements. Therefore, no NESHAPs permit application was required for this remedial action.

### 4.1.8 STATUS OF RADIOLOGICAL AIR EMISSION SOURCES EVALUATED IN 1999

#### 4.1.8.1 WASTE MANAGEMENT RECLAMATION BUILDING

The Waste Management Reclamation Building (Building 865) is the primary facility for handling radioactive waste materials (See Figure 2-6 in Chapter 2). The building is designed to receive bulk radioactive waste of various sizes and configurations, and then to disassemble, decontaminate, reduce the volume, temporarily store, and properly package the waste for shipment offsite. The following is a brief description of six processing areas or equipment systems that were installed to conduct these functions.

- *Lead Melting Area.* A lead melter capable of melting contaminated lead shielding and components is located in this area. This unit has not been used since its installation. When the unit is placed in operation, molten slag that contains the bulk of contamination will be skimmed off, and the remaining molten lead will be recast in molds for reuse as shielding blocks, provided acceptable radiation levels are achieved through the decontamination process.
- *Equipment Decontamination Bath.* The surfaces of contaminated items, such as respirators, are cleaned in the bath using nonhazardous cleaning agents. After the materials are cleaned, they are dried and stored.
- *Fume Hood.* Radioactive wastes are inspected, sorted, and repacked. Any airborne emissions generated during the different handling steps are exhausted through a fume hood equipped with a HEPA filter.
- *Carbon Dioxide Blaster Room.* In this room frozen carbon dioxide pellets will be propelled under pressure to remove surface and fixed contamination from equipment and waste materials. This unit has not been operated to date.
- *Plasma Cutting Torch.* This torch will be used to cut metal waste of various geometries to reduce the volume of the waste and to ensure that it fits into standard radwaste shipping containers. This unit has not been placed into operation since its installation.
- *Waste Compactor.* The compactor uses a 500,000-pound hydraulic ram to reduce the volume of contaminated paper product and miscellaneous metal items. This unit is operational, however, it has not been used to date.

Since each of these waste handling activities has the potential to generate radioactive airborne emissions, the ventilation exhaust systems for each is equipped with a HEPA filter. Ordinarily, radionuclide emissions for these types of intermittent, low dose potential

(i.e., less than 0.1 mrem/year to the maximally exposed individual) operations are estimated using NESHAPs Appendix D methods through knowledge of the radionuclides in the waste and their quantities. Since exact source terms for the types of wastes processed in the Reclamation Building are often not readily available making such estimates difficult, sampling systems were designed for each exhaust stack to directly and continuously monitor radiological emissions during waste handling operations. This level of monitoring is greater than what is prescribed under NESHAPs Subpart H for these types of sources.

Each monitoring system was designed to comply with specific requirements of 40 CFR 61.93(b), particularly those for the periodic measurement of flow rate, monitoring of the effluent by direct extraction, and monitoring the effluent using representative samples that are withdrawn continuously when the waste handling equipment is operational. Installation of the stack monitoring systems commenced in 1999 and was completed in March 2000. Since the HEPA filter pumps were operated intermittently in 2000, no periodic samples were analyzed during the year.

#### 4.1.8.2 HIGH VACUUM THERMAL DESORPTION FOR CHEMICAL HOLES PROJECT

During this project, mercury contaminated mixed waste recovered from the chemical holes area was processed in a high vacuum thermal desorption chamber. Exhaust air from the thermal desorption chamber passed through two HEPA filters to trap particulates before being released to the ambient air. Other controls included two water-cooled impingers (two 30-gallon carbon steel vessels filled with water chilled to 35 - 45°F) to condense out mercury vapors, and two in-series carbon beds to recover any residual mercury vapors. Using the CAP88-PC modeling program in 1999, the effective dose equivalent to the maximally

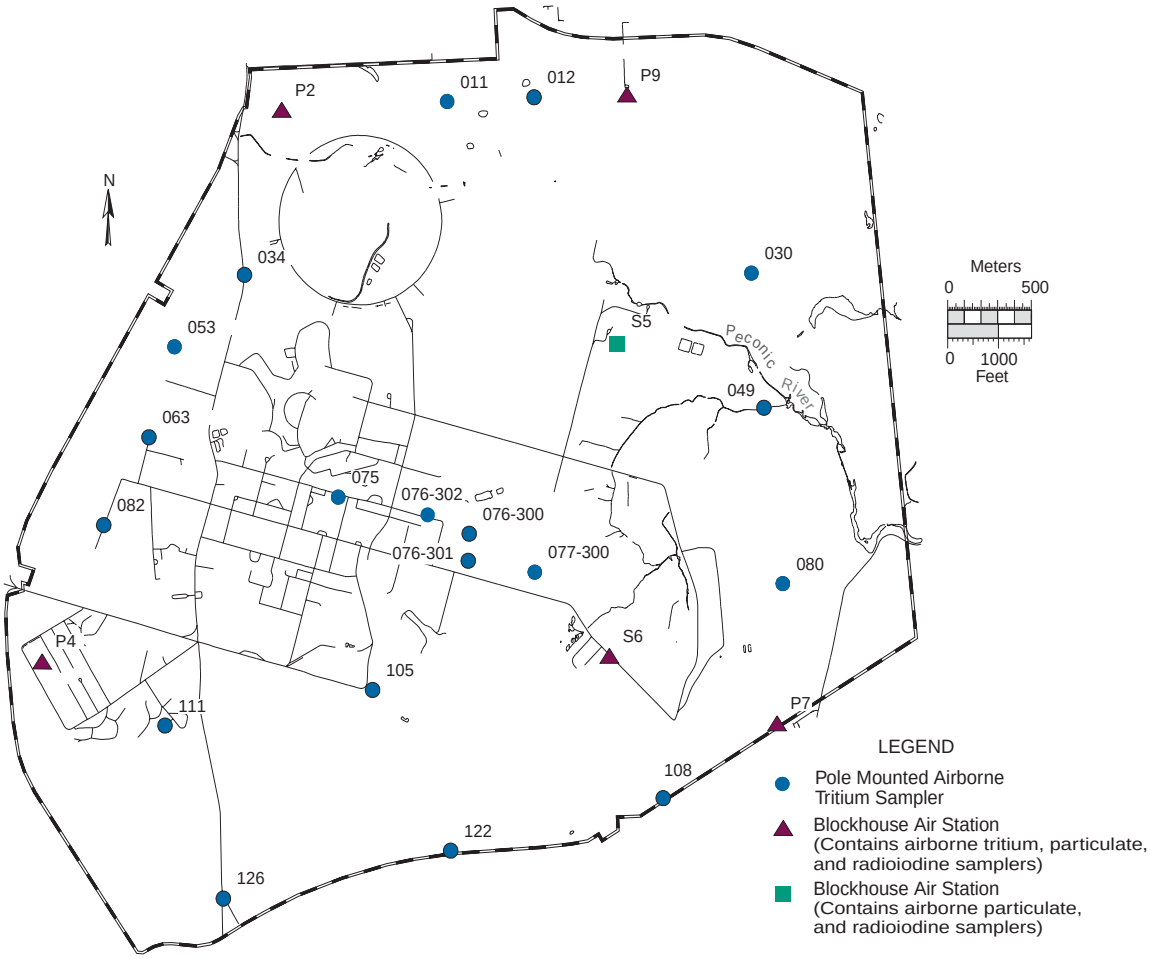


**Figure 4-4. Onsite Ambient Air Monitoring Stations.**

exposed individual was estimated at 6.54 mrem/year (65.4 µSv/yr) under the most conservative assumptions. Since the CAP88-PC modeling did not take into account the effectiveness of the engineering controls in reducing particulate emissions, follow-up air samples were collected as the wastes were processed (from January to June 2000) using a continuous flow portable sampler equipped with a radionuclide filter. The samples were analyzed for gamma emitters, and small quantities of americium-241, cesium-137, and zinc-65 were detected in the samples. Using the sample results, a second NESHAPs evaluation was performed with the CAP88-PC modeling program. The revised effective dose equivalent to the maximally exposed individual was 8.03E-08 mrem/yr (8.03E-07 µSv/yr) for this activity.

### 4.2 AMBIENT AIR MONITORING FOR RADIONUCLIDES

As part of the Environmental Monitoring Program, an array of monitoring stations is in place around the BNL site for collection of air samples to determine ambient radiological air quality. Samplers are located in six dedicated blockhouses (see Figure 4-4 for locations). The blockhouses are fenced for security purposes to control access and protect costly sampling equipment. At each blockhouse, glass-fiber filter paper is used to capture airborne particulate matter, charcoal cartridges are used to collect any potential radioiodines, and silica-gel tubes are used to collect water vapor for tritium analysis (with the exception of Station S5 which does not contain a tritium sampler). Filter paper is collected weekly and analyzed for gross alpha and beta activity using a gas-flow proportional counter. Charcoal cartridges are collected monthly and analyzed by gamma spectroscopy. Since April 1999, silica-gel samples have been collected one week a month for processing by liquid scintillation analysis. Before that, silica-gel samples were collected weekly. Multiple years worth of sampling data with results below the minimum detection limit (MDL) were the basis for reducing sampling frequency. In addition to the blockhouses, 19 pole-mounted, battery-powered silica-gel samplers (used for tritium analysis) are located throughout the site, primarily along the site boundary.

#### 4.2.1 GROSS ALPHA AND BETA ACTIVITY

Particulate filter analytical results for gross alpha and beta activity are reported in

**Table 4-2. Gross Activity Detected in Air Particulate Filters (CY 2000).**

| Sample Station | | Gross Alpha (pCi/m$^3$) | Gross Beta (pCi/m$^3$) |
|---|---|---|---|
| P2 | N | 51 | 51 |
| | Max. | 0.0013 ± 0.0009 | 0.0352 ± 0.0024 |
| | Avg. | 0.0004 ± 0.0001 | 0.0123 ± 0.0014 |
| | NBD | 44 | 2 |
| P4 | N | 52 | 52 |
| | Max. | 0.0018 ± 0.0007 | 0.0018 ± 0.0032 |
| | Avg. | 0.0005 ± 0.0001 | 0.0005 ± 0.0018 |
| | NBD | 43 | 0 |
| P7 | N | 52 | 52 |
| | Max. | 0.0024 ± 0.0010 | 0.0336 ± 0.0027 |
| | Avg. | 0.0005 ± 0.0001 | 0.0134 ± 0.0017 |
| | NBD | 42 | 3 |
| P9 | N | 52 | 52 |
| | Max. | 0.0021 ± 0.0008 | 0.0388 ± 0.0028 |
| | Avg. | 0.0006 ± 0.0001 | 0.0124 ± 0.0014 |
| | NBD | 36 | 1 |
| S5 | N | 52 | 52 |
| | Max. | 0.0019 ± 0.0008 | 0.0298 ± 0.0023 |
| | Avg. | 0.0006 ± 0.0001 | 0.0143 ± 0.0016 |
| | NBD | 36 | 2 |
| S6 | N | 50 | 50 |
| | Max. | 0.0031 ± 0.0025 | 0.0474 ± 0.0091 |
| | Avg. | 0.0005 ± 0.0001 | 0.0146 ± 0.0018 |
| | NBD | 41 | 1 |
| **Grand Average** | | 0.0005 ± 0.0001 | 0.0135 ± 0.0009 |

Notes:
See Figure 4-4 for sample station locations.
All values shown with a 95% confidence interval.
N = Number of samples collected.
NBD = Number of samples with results below the minimum detection limit.

Table 4-2. Annual average gross alpha and beta airborne activity levels for the six monitoring stations were equal to 0.0005 pCi/m$^3$ (0.02 mBq/m$^3$) and 0.0135 pCi/m$^3$ (0.52 mBq/m$^3$), respectively. Annual gross beta activity trends recorded at Station P7 are plotted in Figure 4-5. The results at this location are typical for the site. The trend shows seasonal variation of concentrations within a range that is representative of natural background levels. The gross alpha activity is not plotted because the vast majority of results were below the MDL. Measurable activity is primarily due to radionuclide decay products associated with natural uranium and thorium.

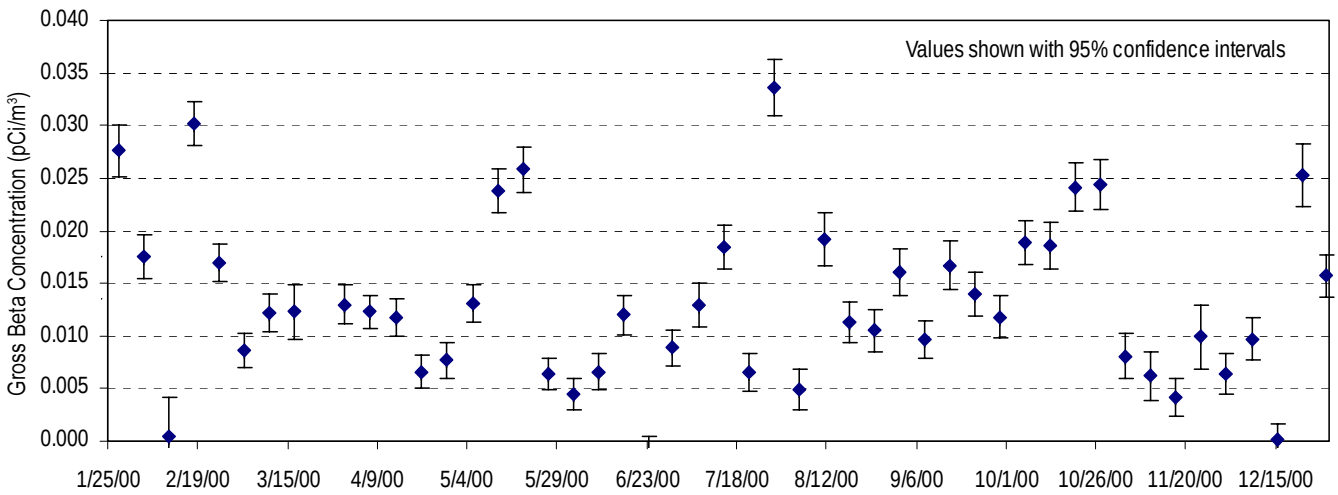


**Figure 4-5. Airborne Gross Beta Concentrations Recorded at Station P7 (CY 2000).**

The New York State Department of Health (NYSDOH) received duplicate filter samples that were collected at Station P7, located at the southeast site boundary. These samples were collected weekly and analyzed by an independent NYSDOH laboratory for gross beta activity. Preliminary analytical results received were comparable to the samples analyzed by the BNL Analytical Services Laboratory. Analytical results for gross beta reported by the NYSDOH laboratory were between 0.006 and 0.025 pCi/m$^3$ (0.22 and 0.93 mBq/m$^3$), while the BNL results ranged from 0.0001 to 0.034 pCi/m$^3$ (0.005 to 1.24 mBq/m$^3$).

As part of a statewide monitoring program, the NYSDOH also collects air samples in Albany, New York, a control location with no potential to be influenced by nuclear facility emissions. The NYSDOH reported in 2000 that airborne gross beta activity at that location varied between 0.0025 and 0.0260 pCi/m$^3$ (0.09 to 0.96 mBq/m$^3$). Sample results measured at BNL generally fall within this range, demonstrating that onsite radiological air quality is consistent with that observed at locations in New York State not located near radiological facilities.

#### 4.2.2 AIRBORNE TRITIUM

Airborne tritium in the form of HTO is monitored throughout the BNL site. In addition to the five blockhouses containing tritium samplers, fourteen pole-mounted monitors (not including those which monitor the Removal Action V Recharge Basin – see Section 4.2.2.1 below) are located at or near the property boundary (see Figure 4-4 for locations). Two additional pole-mounted monitors are centrally located onsite. HTO is collected by using a pump that draws air through a column of silica gel, a water-absorbent medium. The absorbed water is recovered and analyzed using liquid scintillation counting techniques.

Table 4-3 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 super-saturated gel, or the loss of sample during laboratory preparation). Airborne tritium samples were collected from each sampling station once a month. While one location (S6) showed the maximum and average values to be above the typical minimum detection limit range from 1 to 5 pCi/m$^3$ (0.04 to 0.19 Bq/m$^3$), the remainder of the sample results were below the minimum detection limit. The collected data demonstrated that there was no significant difference in ambient tritium concentrations onsite or at the site boundary. With the exception of Station S6, which is located adjacent to the former Hazardous Waste Management Facility, all annual average concentrations were observed to be below the minimum detection limit. The maximum concentration recorded at Station S6 was 54.6 pCi/m$^3$ (2.0 Bq/m$^3$). The higher values observed at this station are most likely due to its proximity to the former Hazardous Waste Management Facility. By comparison,

**Table 4-3. Ambient Airborne Tritium Measurements (CY 2000).**

| Sample Station | Wind Sector | Validated Samples | Maximum (pCi/m$^3$) | Average (pCi/m$^3$) |
|---|---|---|---|---|
| P9 | NE | 12 | 1.3 ± 0.7 | 0.2 ± 0.5 |
| 011 | NNE | 8 | < 2.8 | 0.3 ± 0.5 |
| 012 | NNE | 8 | 2.2 ± 1.3 | 0.1 ± 0.8 |
| P2 | NNW | 11 | < 3.3 | 0.1 ± 0.4 |
| 030 | ENE | 10 | < 1.7 | -0.5 ± 0.5 |
| 034 | NNW | 10 | < 3.4 | 0.4 ± 0.5 |
| 049 | E | 7 | < 1.2 | -0.6 ± 0.5 |
| 053 | NW | 9 | < 3.3 | -0.7 ± 1.2 |
| 063 | W | 12 | < 5.3 | -0.1 ± 0.9 |
| 075 | SW | 9 | < 11.8 | 1.4 ± 1.4 |
| 076-302 | ESE | 8 | < 4.7 | 0.7 ± 0.7 |
| 080 | ESE | 12 | < 3.0 | 0.1 ± 0.5 |
| 082 | W | 11 | < 6.0 | 0.7 ± 1.3 |
| S6 | SE | 12 | 54.6 ± 4.7 | 19.8 ± 8.1 |
| P7 | ESE | 11 | < 1.8 | 0.0 ± 0.5 |
| 105 | S | 10 | < 2.5 | 0.0 ± 0.7 |
| 108 | SE | 9 | < 13.5 | 0.2 ± 1.0 |
| P4 | WSW | 11 | < 1.4 | -0.2 ± 0.4 |
| 111 | SW | 8 | < 4.4 | -0.4 ± 1.6 |
| 122 | SSE | 8 | < 2.8 | 0.2 ± 0.3 |
| 126 | SSW | 10 | < 2.6 | -0.3 ± 0.7 |
| **Grand Average** | | | | 1.2 ± 0.8 |

Notes:
See Figure 4-4 for station locations.
Wind sector is the downwind direction of the sample station from the five BNL facilities noted in Section 4.1 that are subject to NESHAPs Subpart H continuous monitoring requirements.
All values reported with a 95% confidence interval.
Typical minimum detection limit for tritium is between 1 - 5 pCi/m$^3$.

the DOE Order 5400.5 derived concentration guide for tritium in air is 100,000 pCi/m$^3$ (3.7 kBq/m$^3$). The airborne derived concentration guide is the concentration of a radionuclide in air, which if inhaled at that level for one year, would result in an effective dose equivalent of 100 mrem (1 mSv) to the maximally exposed individual. Therefore, all BNL station measurements of ambient tritium are less than 0.1% of the DOE derived concentration guide value. Observed concentrations of tritium at the sampling stations in 2000 are comparable to concentrations observed in 1999, but are considerably lower than measured station concentrations in 1996 when the HFBR released 48 Ci of HTO to the atmosphere.

#### 4.2.2.1 REMOVAL ACTION V RECHARGE BASIN

In 1997, an interim pump-and-recharge system was constructed to control the leading edge of the plume of tritium associated with the leakage of the spent-fuel storage pool at the HFBR. Three extraction wells are being used to pump groundwater containing both tritium and volatile organic compounds from approximately 150 feet (46 meters) below ground surface to carbon filtration units, and ultimately to the Removal Action (RA) V recharge basin, located 3,000 feet (914 meters) to the north of the plume edge. (The volatile organic compounds being treated by this system are from sources unrelated to the HFBR.) Using assumptions that later proved to be very conservative, the recharge basin was evaluated, prior to the start of pumping operations, as a potential air emission source for NESHAPs compliance. (See Section 5.1.6.1 of the *BNL Site Environmental Report for Calendar Year 1997* [BNL 1999] for a discussion of that evaluation.)

During 2000, airborne HTO monitoring in the vicinity of the RA V recharge basin continued. Two monitors are installed immediately adjacent to the basin at the northeast and southeast corners (Stations 076-300 and 076-301 on Figure 4-4), downwind of the predominant winds on site (see BNL wind rose in Chapter 1, Figure 1-10). An additional station was placed near the National Weather Service building (Station 077-300), approximately 0.2 mile (0.3 km) to the east of the basin. For the year 2000, none of the 32 validated samples exceeded the minimum detection limit (See

**Table 4-4. Ambient Tritium Monitoring Results at RA V Recharge Basin (CY 2000).**

| Location | Validated Samples | Detections | Maximum (pCi/m$^3$) | Average (pCi/m$^3$) |
|---|---|---|---|---|
| Northeast corner of basin (076-300) | 11 | 0 | < 8.7 | 0.2 ± 0.8 |
| Southeast corner of basin (076-301) | 11 | 0 | < 1.4 | -0.4 ± 0.8 |
| National Weather Service Building (077-300) | 10 | 0 | < 3.7 | -0.1 ± 0.8 |

Notes:
See Figure 4-4 for sample station locations.
Typical minimum detection limit for tritium is between 1 and 5 pCi/m$^3$.

Table 4-4 for results). These results are consistent with prior findings, which show that the majority of tritium samples collected since the tritium surveillance began in 1997 were below the minimum detection limit.

### 4.3 NONRADIOLOGICAL AIRBORNE EMISSIONS

Various state and federal regulations governing nonradiological releases require facilities to conduct periodic or continuous emissions monitoring in order to demonstrate compliance with emission limits. BNL has several emission sources subject to state and/or federal regulatory requirements that do not require emissions monitoring (see Chapter 3 for more details). The Central Steam Facility (CSF) is the only BNL emission source required to monitor nonradiological emissions.

The CSF supplies steam for heating and cooling to BNL major facilities 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 Boiler Nos. 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 was installed in 1965, and has a heat input of 65.3 MW (225 MMBtu/hr). The newest units, Boilers No. 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).

Because of their design, heat inputs, and dates of installation, Boiler Nos. 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. As such, these boilers are equipped with continuous emission monitors for nitrogen oxides ($NO_X$). Boiler No. 7 emissions are also continuously monitored for opacity. To measure combustion efficiency, both boilers are also monitored for carbon dioxide ($CO_2$). Continuous emissions monitoring results from the two boilers are reported on a quarterly basis to the U.S. Environmental Protection Agency and the New York State Department of Environmental Conservation.

From May 1 to September 15 (the peak ozone period), compliance with the 0.30 lbs/MMBtu (129 ng/J) $NO_x$ emissions standard 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 continuous emission monitoring system emission rate is used to establish compliance. Boiler No. 7 opacity levels are recorded as 6-minute averages. Measured opacity levels cannot exceed 20% opacity, except for one 6-minute period per hour of not more than 27% opacity. In 2000, there were no measured exceedances of the $NO_x$ emission standard for either boiler, or excess opacity measurements on Boiler No. 7.

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 No. 5, and natural gas trains were installed to connect the gas main to Boiler Nos. 5 and 7. In 1998, existing steam atomized oil burners on Boiler No. 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.

**Table 4-5. Central Steam Facility Fuel Use and Emissions (1996 - 2000)**

| | Annual Fuel Use | | | Emissions | | | |
|---|---|---|---|---|---|---|---|
| Year | # 6 Oil ($10^3$ gals) | # 2 Oil ($10^3$ gals) | Natural Gas ($10^6$ $ft^3$) | TSP (tons) | $NO_x$ (tons) | $SO_2$ (tons) | VOCs (tons) |
| 1996 | 4,782.55 | 52.77 | 0.00 | 14.0 | 104.9 | 109.0 | 0.7 |
| 1997 | 3,303.43 | 10.23 | 190.65 | 13.7 | 83.5 | 75.1 | 1.0 |
| 1998 | 354.28 | 9.44 | 596.17 | 2.7 | 75.1 | 8.9 | 1.7 |
| 1999 | 682.76 | 2.77 | 614.98 | 5.1 | 53.5 | 16.7 | 1.8 |
| 2000 | 2,097.32 | 0.82 | 342.40 | 9.5 | 81.6 | 45.0 | 1.2 |

Notes:
TSP - Total Suspended Particulates
VOCs - Volatile Organic Compounds

In 2000, increased residential consumption of natural gas caused natural gas prices to rise substantially. As the price of natural gas fluctuated and exceeded that of residual fuel (No. 6 oil), the CSF burned residual fuel. The CSF used more than three times as much residual fuel in 2000 as it had in 1999, while total natural gas use declined by nearly 45% (see Table 4-5). Consequently, annual emissions of particulates, $NO_x$, and $SO_2$ were 4.4 tons, 28.1 tons, and 28.3 tons higher than the respective totals for 1999. Nonetheless, annual CSF emissions of these pollutants were 32%, 22%, and 59% lower than respective totals in 1996.

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Chapter 5

# Water Quality

Some operations at BNL discharge, or have the potential to discharge, wastewater containing very low levels of radiological, organic, and/or inorganic contaminants. Monitoring ensures that these effluents comply with all applicable requirements, and that the public, employees, and environment are protected.

Analytical data for 2000 showed that the average gross alpha and beta activity levels in the Sewage Treatment Plant (STP) discharge were within the range typical of background surface waters. Tritium releases to the Peconic River continued to drop and were the lowest since monitoring began in 1966; 90% of the daily samples had tritium concentrations below the minimum detection limit. Cesium-137 was detected only once in the STP effluent during the year at less than 1% of the drinking water standard.

Non-radiological monitoring of the STP 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 not affected by STP discharges demonstrated that elevated amounts of aluminum, silver, lead, iron, and zinc detected within the Peconic River are a result of natural geology. The low pH detected within several sections of the river was due to natural causes.

Based upon the 2000 nonradiological data, the Peconic River water quality is comparable to other local fresh water rivers and is of consistent quality both upstream and downstream of the BNL STP discharge. Radiological data for the year showed no impact from BNL operations downstream of the BNL site. Low concentrations of tritium were detected at the STP outfall, but only sporadic detections were found at the first monitoring station downstream. The maximum concentration downstream of the STP discharge was approximately 7% of the drinking water standard.

### 5.1 SURFACE WATER MONITORING PROGRAM

Treated wastewater from the BNL Sewage Treatment Plant (STP) is discharged into the headwaters of the Peconic River. This discharge is a New York State Department of Environmental Conservation permitted point source discharge. Effluent limits are based upon the water quality standards derived from the New York State Department of Environmental Conservation and 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 point of discharge. The Carmans River is monitored as a control location for comparative purposes as it is not affected by BNL operations.

To assess the true quality of Peconic River background water, BNL monitors a location upstream from all Laboratory operations. This sampling station (Station HY) is located onsite and just east of the William Floyd Parkway. During 1999, Station HY was monitored for radiological parameters only. In 2000, non-radiological monitoring was added to the sampling protocol for this station. Detailed information regarding BNL's sampling program is documented in the *BNL Environmental Monitoring Plan* (BNL 2000).

On the BNL site, the Peconic River is an intermittent stream. Offsite flow only occurs during periods of sustained precipitation, typically in the spring. Due to the very wet early summer in 2000 (see Figure 1-11), offsite flow was recorded from April through early September. Figure 5-1 shows one of the many spillways located throughout the Peconic River.

**Figure 5-1. Peconic River Spillway between Donohue's Pond and Forge Pond.**

The following sections describe BNL's surface water monitoring and surveillance program.

### 5.2 SANITARY SYSTEM EFFLUENTS

The STP outfall (Outfall 001) is a discharge point operated under a State Pollutant Discharge Elimination System (SPDES) permit. Figure 5-2 shows a schematic of the STP and STP sampling locations. The BNL STP treatment system includes: (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) intermittent sand filtration for final effluent polishing, and (5) ultraviolet disinfection for bacterial control prior to discharge to the Peconic River. During the aeration process, an oxygen minimizer causes the microorganisms to use nitrate-bound oxygen for respiration, liberating nitrogen gas and consequently reducing 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. Since aquatic vegetation utilizes oxygen during nighttime hours, too much plant life can deprive a water system of oxygen needed by fish and other aquatic organisms for survival. By reducing the concentration of nitrogen in the STP discharge, plant growth within the river remains in balance with the nutrients provided by natural sources. During 2000, the STP discharge continuously met the nitrogen limit of 10 mg/L specified in the SPDES permit.

Real-time monitoring of the sanitary waste stream for radioactivity, pH, and conductivity takes place at two locations: approximately 1.1 miles (1.8 km) upstream of the STP and just prior to the point where the influent enters the primary clarifier. The upstream station provides at least 30 minutes advance warning to the STP operator if wastewater that may exceed SPDES limits or BNL effluent release criteria were to enter the sewer system. In addition, effluent leaving the primary clarifier

is monitored a third time for radioactivity. Any influent to the clarifier that does not meet SPDES limits or BNL effluent release criteria would be diverted to lined holding ponds. The total combined capacity of the two holding ponds exceeds 7,000,000 gallons (26.5 million liters) or approximately 12 days of flow. Diversion continues until the effluent's water quality meets the permit limits or release criteria. The requirements for treating the effluent diverted to the holding ponds are evaluated and, if necessary, the waste is treated and reintroduced into the STP at a rate that ensures compliance with SPDES permit limits or BNL effluent release criteria. In 2000, the STP influent was diverted on one occasion due to a false radiation alarm. Inspection of the monitoring system showed that an electrical surge was the most likely cause for a false positive reading at the upstream monitoring location.

Solids separated in the clarifiers are pumped to a digester where they are reduced in volume by anaerobic bacteria. Periodically a fraction of the sludge is emptied into a drying bed. The drying bed uses solar energy to dry the watery sludge to a semisolid cake. Since the dried sludge contains very low levels of radioactivity, it is containerized for offsite disposal at an authorized facility.

In 2000, BNL finalized plans for and began the next phase of STP upgrades. These upgrades include replacement of the anaerobic digester with a digester that uses aerobic organisms to degrade the sludge; upgrades to the pipe distribution system within the sand filters; relining of the holding ponds; and replacement, repair, or relining of approximately 9,000 linear feet (2.7 km) of sewer piping. One important component of the project is the upgrading and cleaning of the sanitary sewer system. Cleaning of the sewer system will remove most of the sludge containing low levels of radioactivity from historical operations, and repair/lining of the sewer lines will provide a liquid tight conduit to the STP, thus reducing leakage to soil or groundwater.

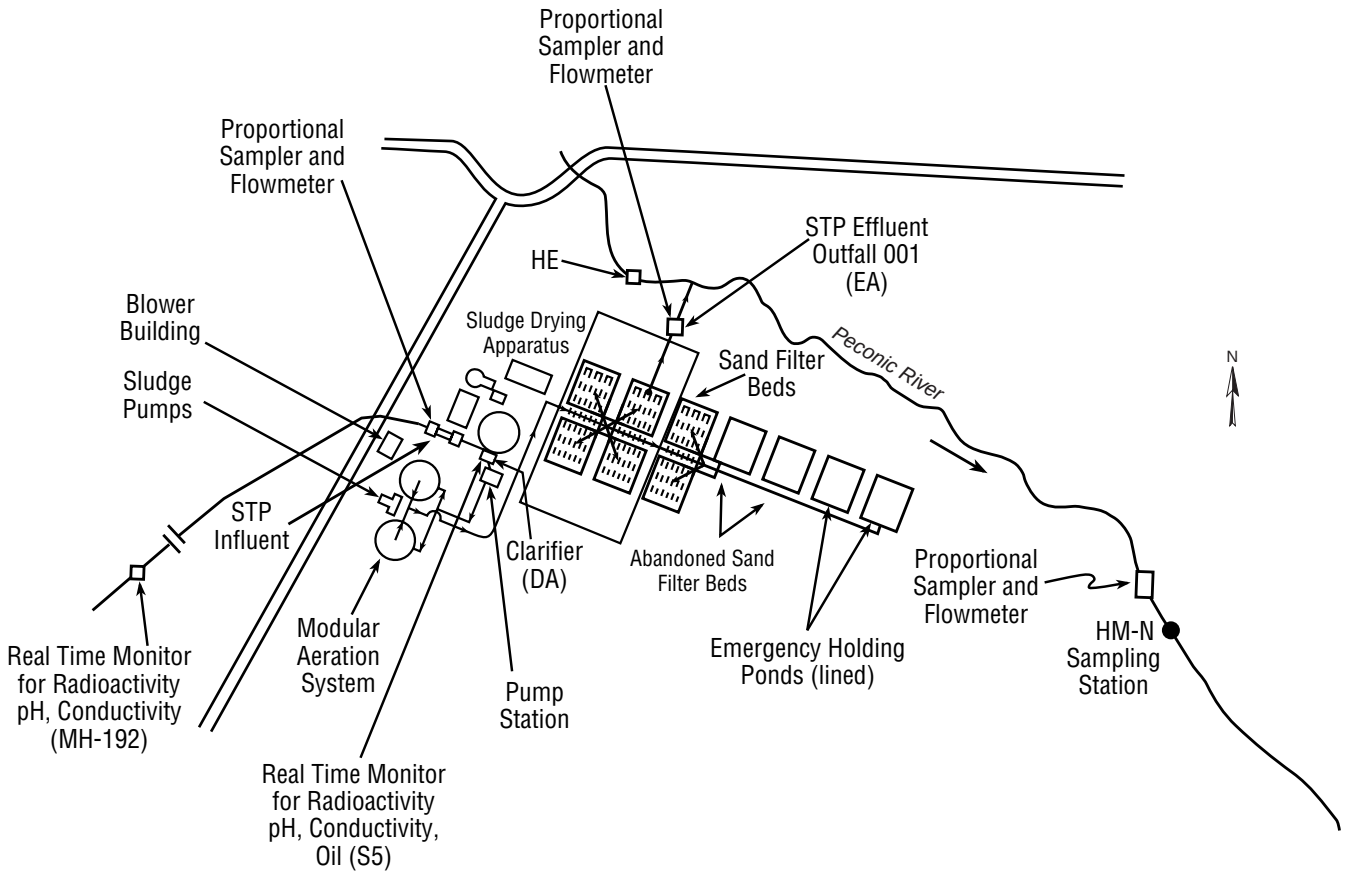


**Figure 5-2. Schematic of Sewage Treatment Plant.**

### 5.2.1 SANITARY SYSTEM EFFLUENT–RADIOLOGICAL ANALYSES

The STP effluent 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 daily on a flow-proportional basis; that is, for every 1,000 gallons (3,780 L) of water treated, approximately 4 fluid ounces (125 ml) of sample are collected and composited into a 5-gallon (19-L) collection container. These samples are analyzed for gross alpha and gross beta activity and tritium concentrations. Samples collected from these locations are also analyzed for gamma-emitting radionuclides and strontium-90 on a monthly basis.

The Safe Drinking Water Act (SDWA) specifies that no individual may receive an annual dose greater than 4 mrem (40 μSv) per year from radionuclides present in drinking water. Although the Peconic River is not used as a direct source of potable water, BNL applies the stringent drinking water standards for comparison purposes, in lieu of DOE wastewater criteria. Under the SDWA, the annual average gross alpha activity limit is 15 pCi/L (0.6 Bq/L) (including radium-226, but excluding radon and uranium). The SDWA also stipulates a 50 pCi/L (1.85 Bq/L) gross beta activity screening level, above which radionuclide-specific analysis is required. BNL goes beyond this basic screening requirement by performing radionuclide-specific gamma analysis regardless of the gross beta activity. Other SDWA-specified drinking water limits are 20,000 pCi/L (740 Bq/L) for tritium and 8 pCi/L (0.3 Bq/L) for strontium-90. For all other radionuclides, Derived Concentration Guides (DCGs) found in DOE Order 5400.5 (DOE 1990), *Radiation Protection of the Public and the Environment,* are used to determine the concentration of the nuclide, which, if continuously ingested over a calendar year, would produce an effective dose equivalent (EDE) of 4 mrem (40 μSv).

Gross activity (alpha and beta) measurements were 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 2000. Annual average gross alpha and beta activity in the STP effluent has remained consistent with levels at control locations for many years. This continued to be the case in 2000. Annual average gross alpha and beta activity at the STP Outfall 001 was 2.0 ± 0.2 pCi/L (0.07 ± 0.01 Bq/L) and 9.5 ± 0.8 pCi/L (0.3 ± 0.03 Bq/L), respectively.

Tritium detected at the STP originates with either High Flux Beam Reactor (HFBR) sanitary system releases, or small, infrequent batch releases that meet BNL discharge criteria from other facilities. Tritium continues to be released from the HFBR at very low concentrations due to evaporative losses of primary coolant and condensation within the air conditioning units. A plot of the 2000 tritium concentrations recorded in the STP effluent is presented in Figure 5-3. A 10-year trend plot of annual average tritium concentrations measured in the STP discharge is shown in Figure 5-4. Annual average concentrations have been declining since 1995.

In 2000, the annual average tritium concentration as measured at the STP outfall (EA, Outfall 001) was 163 pCi/L (4.9 Bq/L). This value is below the average minimum detection limit (MDL) of 350 pCi/L (13.0 Bq/L). A total source term of 0.106 Ci (3.9 million Bq) of tritium was released during the year. This level is slightly less than the discharge recorded for 1999 and is the lowest annual release of tritium to the Peconic River observed since routine measurements began in 1966 (see Figure 5-5). Tritium was detected in only 10% of the daily samples collected at the STP discharge to the Peconic River. The maximum concentration of tritium was 1,900 pCi/L (71 Bq/L) that was detected in November. The increased levels of tritium detected in November were investigated and found to be associated with the HFBR. A definitive source could not be determined. Reduced concentrations of tritium are primarily the result of operations readying the HFBR for permanent closure. In 2000 most of the primary coolant, that has very high concentrations of tritium, was drained from the reactor and shipped offsite. The reactor was subsequently refilled with tap water. This significantly reduced the inventory of tritium at the HFBR. These levels will continue to decline as the HFBR moves into permanent decommissioning.

Table 5-2 presents the gamma spectroscopy analysis of the monthly STP composite samples for radionuclides. During

**Table 5-1. Tritium and Gross Activity Results of Water at the Sewage Treatment Plant (CY 2000).**

| | Monthy Flow (Liters) | Tritium Maximum (pCi/L) | Tritium Average (pCi/L) | Gross Alpha Maximum (pCi/L) | Gross Alpha Average (pCi/L) | Gross Beta Maximum (pCi/L) | Gross Beta Average (pCi/L) |
|---|---|---|---|---|---|---|---|
| **STP Clarifier** | | | | | | | |
| January | 5.33E + 07 | 363 ± 213 | 109 ± 45 | 6.3 ± 2.8 | 1.4 ± -0.8 | 20.8 ± 6.4 | 9.6 ± 1.7 |
| February | 5.27E + 07 | 325 ± 218 | 117 ± 48 | 4.3 ± 2.2 | 1.4 ± -0.6 | 73.1 ± 9.0 | 14.2 ± 6.3 |
| March | 6.24E + 07 | 445 ± 189 | 147 ± 44 | 3.6 ± 2.0 | 1.6 ± 0.5 | 14.5 ± 5.9 | 8.3 ± 1.2 |
| April | 5.65E + 07 | 305 ± 199 | 69 ± 51 | 3.4 ± 2.1 | 1.9 ± 0.5 | 15.2 ± 5.9 | 7.6 ± 1.4 |
| May | 6.05E + 07 | 2540 ± 326 | 225 ± 215 | 5.6 ± 2.9 | 1.1 ± 0.6 | 28.0 ± 6.8 | 8.7 ± 2.5 |
| June | 8.77E + 07 | < 215 | 92 ± 56 | 4.0 ± 2.4 | 1.6 ± 0.6 | 13.4 ± 6.2 | 5.6 ± 1.5 |
| July | 6.51E + 07 | < 293 | 161 ± 36 | 4.0 ± 2.4 | 1.6 ± 0.8 | 95.3 ±10.1 | 19.6 ± 10.2 |
| August | 8.05E + 07 | 35 ± 209 | 92 ± 47 | 4.0 ± 2.2 | 1.7 ± 0.6 | 45.5 ± 7.8 | 16.8 ± 3.6 |
| September | 7.88E + 07 | < 261 | 60 ± 37 | 5.9 ± 2.6 | 1.8 ± 0.7 | 49.8 ± 7.8 | 13.4 ± 4.9 |
| October | 8.04E + 07 | 284 ± 181 | 69 ± 53 | 4.7 ± 2.3 | 1.8 ± 0.6 | 16.9 ± 5.7 | 11.3 ± 1.1 |
| November | 6.57E + 07 | 3350 ± 351 | 535 ± 360 | 7.3 ± 3.1 | 2.7 ± 0.9 | 26.5 ± 6.6 | 11.9 ± 2.1 |
| December | 4.92E + 07 | < 329 | 99 ± 35 | 5.0 ± 2.6 | 1.7 ± 0.8 | 13.8 ± 5.9 | 6.2 ± 2.0 |
| Annual Average | | | 145 ± 39 | | 1.7 ± 0.2 | | 11.0 ± 1.2 |
| **STP Outfall** | | | | | | | |
| January | 4.10E + 07 | < 352 | 116 ± 39 | 6.6 ± 2.8 | 1.9 ± 0.8 | 12.1 ± 5.4 | 6.3 ± 1.1 |
| February | 4.48E + 07 | 860 ± 238 | 181 ± 75 | 4.7 ± 2.7 | 1.6 ± 0.6 | 13.6 ± 5.5 | 8.6 ± 1.2 |
| March | 5.25E + 07 | 410 ± 214 | 181 ± 41 | 4.8 ± 2.4 | 1.8 ± 0.6 | 14.5 ± 5.9 | 8.5 ± 1.6 |
| April | 5.08E + 07 | < 334 | 152 ± 49 | < 4.35 | 1.5 ± 0.6 | 14.5 ± 5.8 | 7.0 ± 1.5 |
| May | 5.71E + 07 | 1880 ± 283 | 218 ± 154 | 3.8 ± 2.4 | 1.8 ± 0.5 | 14.9 ± 8.3 | 14.9 ± 5.7 |
| June | 8.16E + 07 | 399 ± 216 | 144 ± 43 | 5.2 ± 2.8 | 1.7 ± 0.7 | 15.4 ± 6.0 | 8.3 ± 1.8 |
| July | 6.15E + 07 | 298 ± 190 | 155 ± 37 | 4.1 ± 2.0 | 1.8 ± 0.5 | 18.8 ± 6.5 | 10.0 ± 2.0 |
| August | 7.30E + 07 | 450 ± 205 | 106 ± 53 | 9.3 ± 3.2 | 2.2 ± 0.9 | 23.7 ± 6.4 | 11.8 ± 1.9 |
| September | 6.73E + 07 | < 301 | 86 ± 37 | 8.0 ± 3.1 | 1.9 ± 1.1 | 19.9 ± 6.4 | 11.9 ± 1.8 |
| October | 5.11E + 07 | 316 ± 175 | 92 ± 49 | 8.7 ± 2.9 | 3.1 ± 0.9 | 29.4 ± 6.5 | 10.7 ± 2.5 |
| November | 4.26E + 07 | 1900 ± 280 | 420 ± 212 | 5.0 ± 2.7 | 2.6 ± 0.6 | 18.8 ± 6.2 | 10.0 ± 1.7 |
| December | 4.41E + 07 | 466 ± 181 | 147 ± 52 | 4.0 ± 2.4 | 2.0 ± 0.5 | 14.1 ± 5.9 | 5.9 ± 1.6 |
| Annual Average | | | 163 ± 27 | | 2.0 ± 0.2 | | 9.5 ± 0.8 |
| **Total Release** | 6.67E + 08 | | 106 (mCi) | | 2.0 (mCi) | | 6.6 (mCi) |
| **SDWA Limit** | | | 20,000 (pCi/L | | 15.0 (pCi/L | | 50.0 (pCi/L) |
| **Average MDL** | | | 319 (pCi/L) | | 3.0 (pCi/L) | | 8.7 (pCi/L) |

Notes:
All values shown with a 95% confidence interval.
To convert values from pCi to Bq, divide by 27.03.
MDL = Minimum Detection Limit
SDWA = Safe Drinking Water Act

2000, the samples showed the presence of cesium-137 only once in the STP effluent. Cesium-137 was not detected at all in the influent. The concentration of cesium-137 detected in the effluent was approximately 1% of the SDWA drinking water standard. The presence of cesium-137 in the STP effluent is due to the continued leaching of very small amounts of cesium-137 from the STP sand filter beds. This radionuclide was deposited during historic releases to the site sanitary system. The cesium-137 concentrations in the STP influent and effluent have been steadily decreasing since 1990, as shown in Figure 5-6. Total releases for 2000 were approximately one-half of 1999 levels. Upgrades to the site sewer system, specifically cleaning and relining/repairing of the piping systems, may be attributing to the decline in cesium-137 releases. Although a few of the individual daily samples showed low-level detections of cobalt-60 and manganese-54 (corrosion products typically found in piping systems exposed to radioactive fields) in the influent, these nuclides were not detected in the STP effluent. Zinc-65 was detected in a single

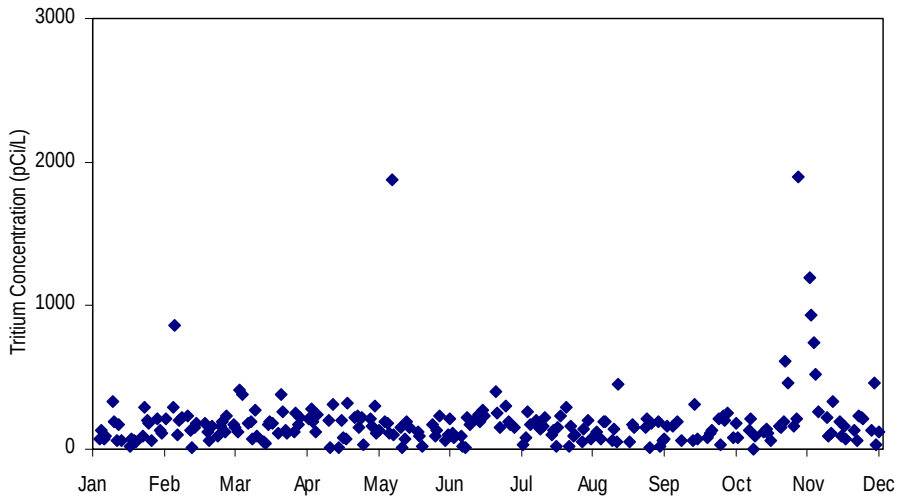


**Figure 5-3. Sewage Treatment Plant Effluent Tritium Concentrations (CY 2000).**

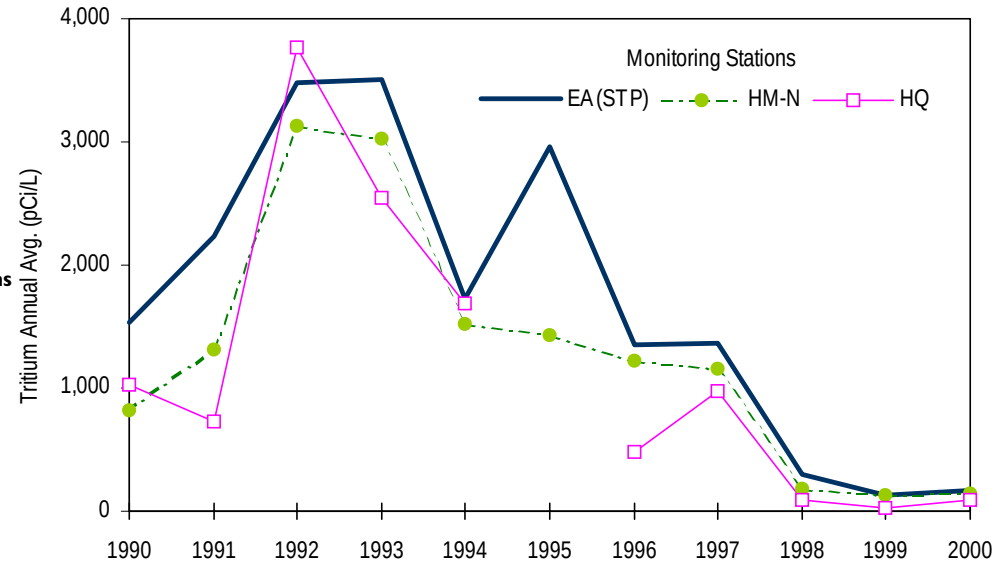


**Figure 5-4. Sewage Treatment Plant/Peconic River Annual Average Tritium Concentrations (1990-2000).**

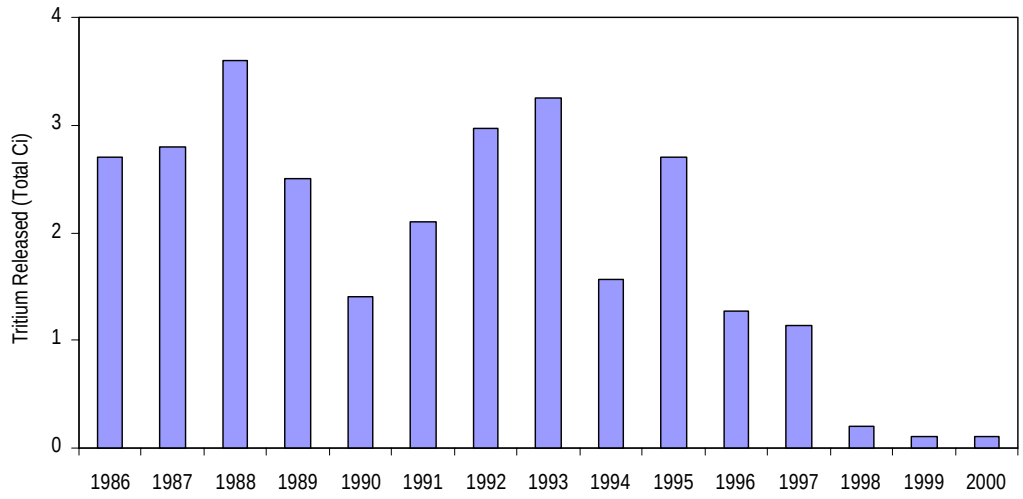


**Figure 5-5. Tritium Released to the Peconic River, 15 Year Trend (1986 – 2000).**

**Table 5-2. Gamma-Emitting Radionuclides and Strontium-90 Results of Water at the Sewage Treatment Plant (CY 2000).**

| | Flow (Liters) | Co-60 (pCi/L) | Cs-137 (pCi/L) | Be-7 (pCi/L) | Na-22 (pCi/L) | Sr-90 (pCi/L) |
|---|---|---|---|---|---|---|
| **STP Clarifier** | | | | | | |
| January | 5.33E+ 07 | ND | ND | ND | ND | < 0.16 |
| February | 5.27E+ 07 | ND | ND | ND | ND | < 0.17 |
| March | 6.24E+ 07 | ND | ND | ND | ND | < 0.16 |
| April | 5.65E+ 07 | ND | ND | ND | ND | < 0.16 |
| May | 6.05E+ 07 | ND | ND | ND | ND | < 0.16 |
| June | 8.77E+ 07 | ND | ND | ND | ND | < 0.17 |
| July | 6.51E+ 07 | ND | ND | ND | ND | < 1.05 |
| August | 8.05E+ 07 | ND | ND | ND | ND | 0.15 ± 0.10 |
| September | 7.88E+ 07 | ND | ND | ND | ND | 0.14 ± 0.10 |
| October | 8.04E+ 07 | ND | ND | ND | ND | < 0.17 |
| November | 6.57E+ 07 | ND | ND | ND | ND | < 0.16 |
| December | 4.92E+ 07 | ND | ND | ND | ND | < 0.18 |
| **STP Outfall** | | | | | | |
| January | 4.10E+ 07 | ND | ND | ND | ND | < 0.16 |
| February | 4.48E+ 07 | ND | ND | ND | ND | < 0.16 |
| March | 5.25E+ 07 | ND | ND | ND | ND | < 0.16 |
| April | 5.08E+ 07 | ND | ND | ND | ND | < 0.16 |
| May | 5.71E+ 07 | ND | ND | ND | ND | < 0.16 |
| June | 8.16E+ 07 | ND | ND | ND | ND | 1.31 ± 0.20 |
| July | 6.15E+ 07 | ND | ND | ND | ND | < 0.77 |
| August | 7.30E+ 07 | ND | 1.64 ± 1.01 | ND | ND | < 0.14 |
| September | 6.73E+ 07 | ND | ND | ND | ND | < 0.17 |
| October | 5.11E+ 07 | ND | ND | ND | ND | < 0.14 |
| November | 4.26E+ 07 | ND | ND | ND | ND | 0.14 ± 0.09 |
| December | 4.41E+ 07 | ND | ND | ND | ND | < 0.22 |
| **Total Release** | 6.67E+ 08 | 0 (mCi) | 0.12 (mCi) | 0 (mCi) | 0 (mCi) | 0.11 (mCi) |
| **DOE Order 5400.5 DCG** | | 5,000 (pCi/L) | 3,000 (pCi/L) | 50,000 (pCi/L) | 10,000 (pCi/L) | 1,000 (pCi/L) |
| **Dose Limit of 4 mrem EDE** | | 100 (pCi/L) | 200 (pCi/L) | 6,000 (pCi/L) | 400 (pCi/L) | 8 (pCi/L) |

Notes:
All values shown with a 95% confidence interval.
DCG=Derived Concentration Guide
EDE=Effective Dose Equivalent
ND=Not Detected

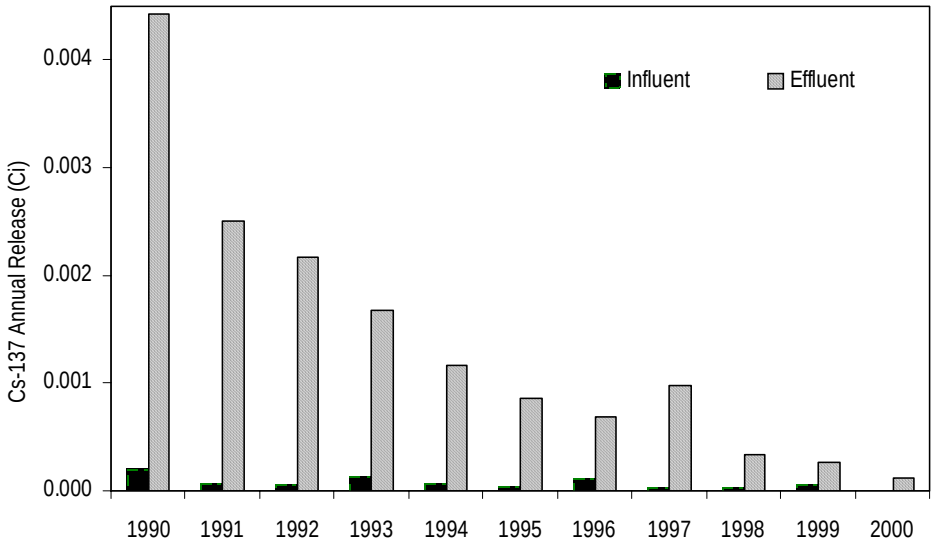


**Figure 5-6. Cesium-137 in the Sewage Treatment Plant Influent and Effluent, 11 Year Trend (1990-2000).**

sample of STP effluent collected in May. While the concentration (439 ± 371 pCi/L [16.2 ± 13.7 Bq/L]) of zinc-65 exceeded the drinking water standard of 400 pCi/L (14.8 Bq/L), the large uncertainty (85%) and the fact that the nuclide was not detected in the STP influent places this result into question.

Stronitum-90 was detected at very low levels in both the STP influent and effluent monthly composite samples on two occasions in 2000. The largest single value of strontium-90 recorded for the STP influent was 0.15 ± 0.1 pCi/L (0.006 ± 0.004 Bq/L) which is 2% of the drinking water standard of 8 pCi/L (0.3 Bq/L). The largest strontium-90 value for an STP effluent sample was 1.3 ± 0.2 pCi/L (0.05 ± 0.008 Bq/L) or 16% of the drinking water standard. The highest strontium-90 concentration detected in the STP influent was approximately 10% of the highest level recorded in 1999. Effluent concentrations are similar to previous years. Strontium-90 was discharged from BNL facilities in the 1950s and 1960s, and has remained in the sludge within the sanitary piping system. One goal of the sanitary sewer-cleaning project is to remove the residual activity and ultimately reduce the concentrations into and released from the STP.

#### 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 under the BNL 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. Daily composite samples of the STP effluent are collected using a flow-proportional refrigerated sampling device (ISCO Model 1600™). The BNL Analytical Services Laboratory analyzes these composite samples for 21 inorganic compounds. 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 inorganic analytical results for the STP samples. Comparison of the effluent data to the SPDES effluent limits (or other applicable standard) shows that the majority of the analytical parameters were within SPDES effluent permit limits (see also the compliance data in Chapter 3). Copper, iron, and zinc were detected, each on one occasion, at concentrations exceeding SPDES limits. Both zinc and iron were detected at elevated levels in regulatory compliance samples as discussed in Chapter 3.

Acetone and methylene chloride were detected at trace levels (< 2.0 µg/L) sporadically throughout the year in grab samples collected from the STP effluent. Methylene chloride was also detected at an elevated concentration of 20 µg/L in a single sample collected in May. This compound was not detected at these levels at any other time during the year. No other organic compounds were detected in the STP discharge during 2000.

### 5.3 PROCESS-SPECIFIC WASTEWATER

Wastewater that may potentially contain constituents above SPDES permit limits or groundwater discharge standards is held by the generator 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 the Peconic River.

The BNL SPDES permit includes requirements for quarterly sampling and analysis of process-specific wastewater discharged from the photographic developing operations in Building 197B, the printed-circuit-board fabrication operations conducted in Building 535B, the metal cleaning operations in Building 498, cooling tower discharges from Building 902, and boiler blow-down from satellite boilers located at Buildings 244 and 423. These operations were monitored for contaminants such as metals, cyanide, VOCs, and semi-VOCs. Analyses of these waste streams showed that, while several contributed contaminants to the STP in concentrations exceeding SPDES permitted levels, the concentration did not affect the quality of the STP effluent.

Process wastewaters that were not expected to be of consistent quality because

**Table 5-3. Sewage Treatment Plant (STP) Average Water Quality and Metals Analytical Results (CY 2000).**

| | STP Influent | | | | STP Effluent | | | | SPDES Limit or Ambient Water Quality Standard[1] |
|---|---|---|---|---|---|---|---|---|---|
| | No. of Samples | Min. | Max. | Avg. | No. of Samples | Min. | Max. | Avg. | |
| pH (SU)[2] | 242 | 6.5 | 8 | NA | 245 | 5.7 | 7.3 | NA | 5.8 - 9.0 |
| Conductivity (μmhos/cm)[2] | | | | | 245 | 21 | 507 | 236 | SNS |
| Temperature (°C)[2,3] | | | | | 245 | 4.4 | 27.2 | 16.9 | SNS |
| Dissolved Oxygen (mg/L) | NA | NA | NA | NA | 245 | 5.1 | 14.2 | 9.3 | SNS |
| Chlorides (mg/L) | 12 | 22.2 | 76.8 | 39.8 | 12 | 17.7 | 39.6 | 30.2 | SNS |
| Nitrate (as N) (mg/L) | 12 | 1.3 | 3.7 | 2.2 | 12 | 2.2 | 8 | 5.1 | 10 (Total N) |
| Sulfates (mg/L) | 12 | 12.2 | 35 | 16 | 12 | 10.5 | 17.5 | 14 | 250 (GA) |
| Aluminum (μg/L) | 12 | 31.6 | 1920 | 631.7 | 12 | 17.1 | 86.1 | 36.9 | 100 (Ionic) |
| Antimony (μg/L) | 12 | < 0.88 | 8.3 | 2.4 | 12 | < 0.88 | < 0.88 | < 0.88 | 3 (GA) |
| Arsenic (μg/L) | 12 | < 3 | 24 | 4.5 | 12 | < 3 | 3.7 | < 3 | 150 (Dissolved) |
| Barium (μg/L) | 12 | 14.1 | 201.5 | 63.5 | 12 | 13.1 | 29.6 | 19.9 | 1000 (GA) |
| Beryllium (μg/L) | 12 | < 0.66 | 1.7 | < 0.66 | 12 | < 0.66 | < 0.66 | < 0.66 | 11 (Acid Soluble) |
| Cadmium (μg/L) | 12 | < 1.1 | 1.2 | < 1.1 | 12 | < 1.1 | 1.1 | < 1.1 | 1.1 (Dissolved) |
| Chromium (μg/L) | 12 | 1.2 | 9.9 | 4.8 | 12 | 1 | 14 | 2.7 | 34.4 (Dissolved) |
| Cobalt (μg/L) | 12 | 0.36 | 4 | 1.1 | 12 | < 0.12 | 0.52 | 0.36 | 5 (Acid Soluble) |
| Copper (μg/L) | 12 | 37.4 | 607.9 | 173 | 12 | 33.8 | 189 | 58.4 | 150 (SPDES) |
| Iron (μg/L) | 12 | 526 | 3411 | 1303 | 12 | < 75 | 1717 | 238 | 370 (SPDES) |
| Mercury (μg/L) | 12 | 0.27 | 4.5 | 1.5 | 12 | < 0.2 | 0.4 | 0.26 | 0.8 (SPDES) |
| Manganese (μg/L) | 12 | 8.1 | 277 | 58.3 | 12 | 3.7 | 13.2 | 7.3 | 300 (GA) |
| Molybdenum (μg/L) | 12 | < 5 | 13.9 | < 5 | 12 | < 5 | < 5 | < 5 | SNS |
| Nickel (μg/L) | 12 | 2.6 | 26 | 7.8 | 12 | 2.9 | 7.2 | 4.3 | 110 (SPDES) |
| Lead (μg/L) | 12 | 6.4 | 98.7 | 26.3 | 12 | < 1.3 | 4.1 | 1.8 | 19 (SPDES) |
| Selenium (μg/L) | 12 | < 5 | 16.8 | 5.3 | 12 | < 5 | 13.9 [4] | < 5 | 4.6 (Dissolved) |
| Silver (μg/L) | 12 | < 1 | 116.6 | 25 | 12 | < 1 | 3.5 | 1.6 | 15 (SPDES) |
| Sodium (μg/L) | 12 | 17.1 | 40 | 27.4 | 12 | 15.9 | 42.5 | 26.2 | SNS |
| Thallium (μg/L) | 12 | < 0.66 | 1.8 | < 0.66 | 12 | < 0.66 | 0.66 | < 0.66 | 8 (Acid Soluble) |
| Vanadium (μg/L) | 12 | < 5.5 | 42.4 | 11.5 | 12 | < 5.5 | 9.7 | < 5.5 | 14 (Acid Soluble) |
| Zinc (μg/L) | 12 | 19.4 | 114 | 53.8 | 12 | 26.9 | 138 | 61.7 | 100 (SPDES) |

Notes:
See Figure 5-2 for locations of the STP influent and effluent monitoring locations.
All analytical results were generated using total recoverable analytical techniques.
For Class C standards, the solubility state for the metal is provided.
SPDES=State Pollutant Discharge Elimination System
NA = Not Applicable
SNS = Standard Not Specified
GA = Class GA (groundwater) Ambient Water Quality Standard
[1] Unless otherwise provided, the reference standard is Class C Surface Water.
[2] The pH and temperature values reported are based upon analysis of daily grab samples.
[3] Continuously monitored by STP operators.
[4] The concentration of selenium detected in several samples analyzed in July is estimated due to blank contamination. Analysis of the method blank showed detectable levels of selenium very similar to those found in the samples.

they were not routinely generated were held for characterization before release to the site sewer system. The process wastewaters typically included ion-exchange column regeneration wastes, primary closed-loop cooling water, 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 compared to the SPDES effluent limits and BNL effluent criteria. If the concentrations were within limits, authorization for sewer disposal was granted; if not, alternate means of disposal were pursued. Any waste that contained elevated levels of hazardous or radiological contaminants in concentrations that exceed BNL effluent criteria were sent to the BNL Waste Management Facility for proper disposal.

In 2000, as part of the Laboratory's commitment to pollution prevention, the Laboratory initiated a revision to its administrative authorization criteria for wastewater containing low levels of radionuclides. This revision is based upon the Environmental As Low As Reasonably Achievable (also known as E-ALARA) concept, whereby the Laboratory will strive to minimize emissions and effluents to the lowest levels technically achievable and economically feasible. The revised criteria will be set at a fraction of the drinking water standards. Effluents that do not meet these stringent criteria will either be managed offsite or must be reviewed by senior management for consideration of institutional risk. The authorization criteria will be finalized and documented in Laboratory-wide standard operating procedures in 2001. This practice is much more stringent than industry standards and supports the Laboratory's commitment to maintaining a clean environment.

### 5.4 RECHARGE BASINS

Recharge basins are used for the disposal of "clean" wastewater streams including once through cooling water, stormwater runoff, or 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 5-7 depicts the locations of BNL's discharges to recharge basins. An overall schematic of water use at BNL is presented in Figure 5-8. Nine recharge basins are used for the management of once through

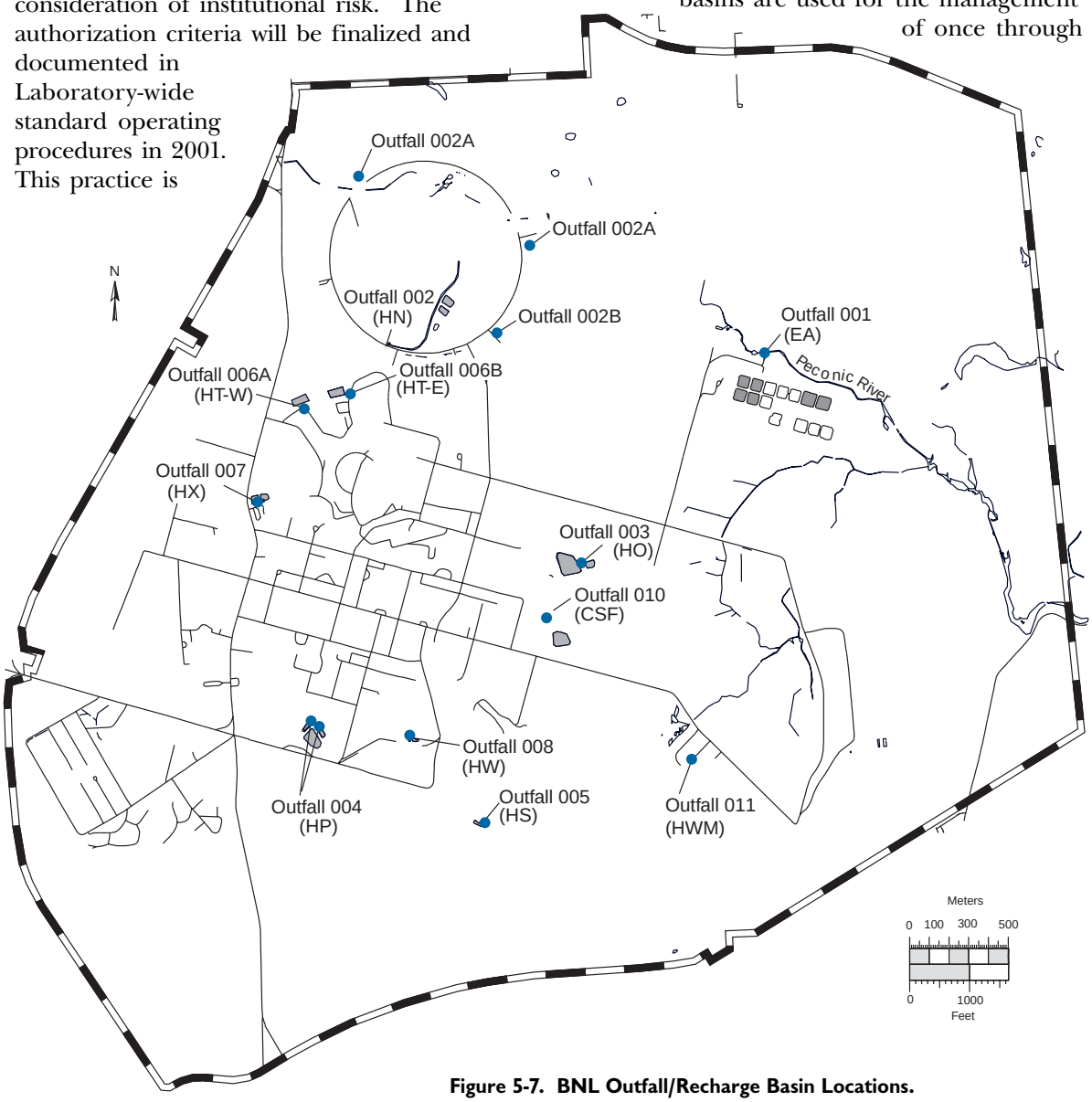


**Figure 5-7. BNL Outfall/Recharge Basin Locations.**

cooling water, cooling tower blowdown, and stormwater runoff as described below:

- 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 Bldg. 555 (Chemistry Dept.), and minimal cooling tower blowdown from the National Synchrotron Light Source.
- Basin HX receives Water Treatment Plant filter backwash water.
- Basin HP receives once-through cooling water from the Brookhaven Medical Research Reactor.
- Basin HO receives cooling water and cooling tower discharges from the AGS, and stormwater runoff from the area surrounding the HFBR.
- Several other recharge areas are used exclusively for discharging stormwater runoff including Basin HW in the warehouse area, Basin CSF at the Central Steam Facility, and Basin HWM at the former Hazardous Waste Management Facility.

Each of the recharge basins is a permitted point source discharge under BNL's SPDES permit. Where required by the permit, the outfall to the basin is equipped with a flow monitoring station and weekly recordings of flow are collected, along with records of pH, conductivity, and temperature. The specifics of the SPDES compliance monitoring program are provided in Chapter 3. To supplement the SPDES compliance monitoring program, samples are also routinely collected and analyzed under the environmental monitoring program for VOCs, metals, and anions. During 2000, water samples were collected from Basins HN, HO, HP, HS, HT-E, HT-W, HW, HX, and CSF.

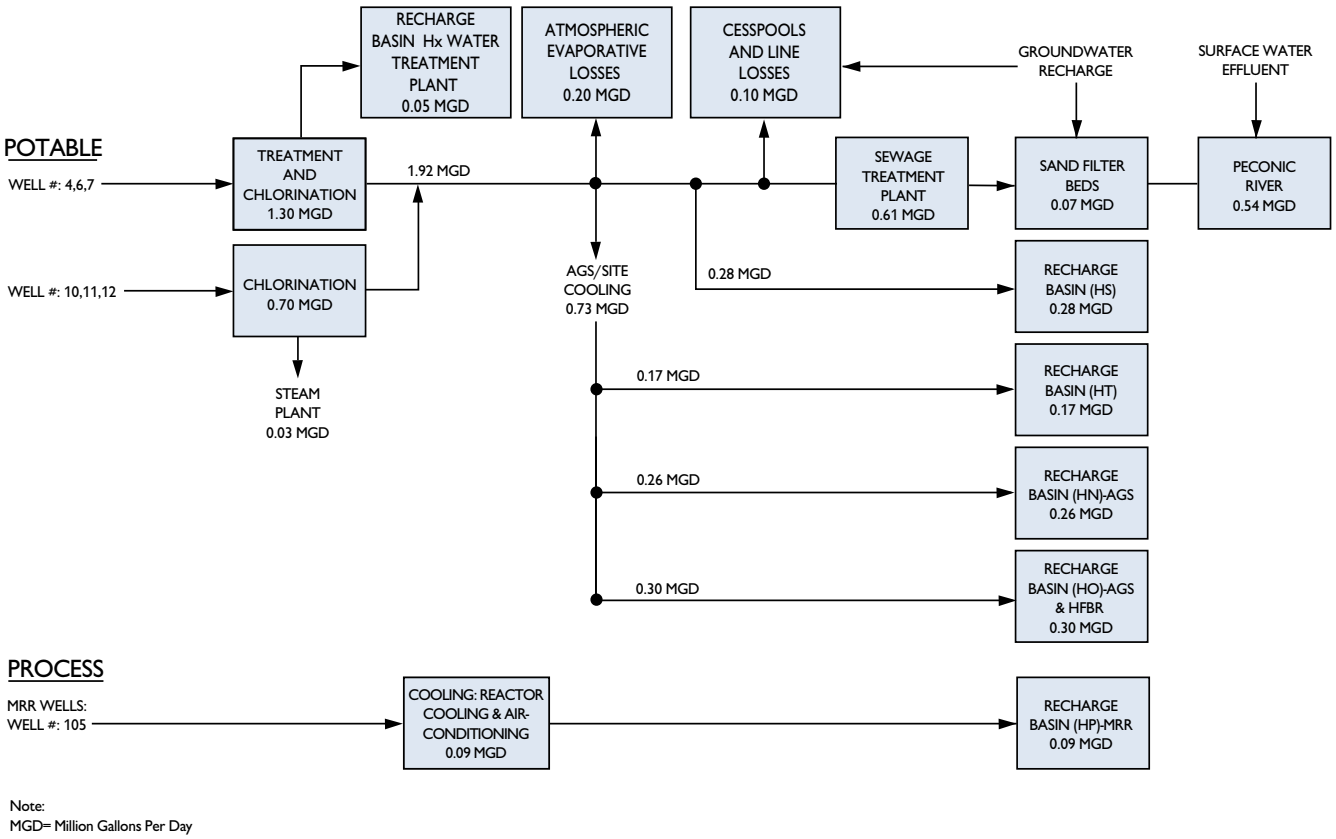


**Figure 5-8. Schematic of Water Use and Flow at BNL for 2000.**

### 5.4.1 RECHARGE BASINS - RADIOLOGICAL ANALYSES

Discharges to the recharge basins were sampled throughout the year to measure concentrations of gross alpha and beta activity, gamma-emitting radionuclides, and tritium. Radiological results for water samples collected at the recharge basins are presented in Table 5-4. Review of the data showed there were detectable levels of beta activity in Basins HN and HT-W. The accompanying gamma analysis of water samples collected from these basins showed that only potassium-40 was detectable in these water samples. Potassium-40 is a naturally occurring radionuclide. No gamma-emitting radionuclides attributable to BNL operations were detected in any of the recharge basins. Recharge Basin HN also exhibited slightly elevated levels of tritium. This recharge basin receives cooling water discharges from the AGS. At the AGS, tritium is produced by the interaction of high-energy protons and secondary radiation (due to beam/target interactions) with cooling water. The maximum concentration of tritium 2,280 pCi/L [84.4 Bq/L]) in this discharge was approximately 10% of the drinking water standard.

**Table 5-4. Radiological Analysis Results of Outfall/ Recharge Basin Water (CY 2000).**

| Basin | | Gross Alpha (pCi/L) | Gross Beta (pCi/L) | Tritium (pCi/L) |
|---|---|---|---|---|
| HN | N | 4 | 4 | 4 |
| | Max. | 0.9 ± 0.6 | 53.9 ± 2.6 | 2,280 ± 299 |
| | Avg. | 0.5 ± 0.22 | 2.3 ±18.5 | 648 ± 935 |
| HO | N | 4 | 4 | 5 |
| | Max. | 6.9 ± 1.0 | 8.2 ± 1.5 | < 319 |
| | Avg. | 2.0 ± 2.8 | 4.3 ± 3.1 | 30 ± 121 |
| HP | N | 4 | 4 | 4 |
| | Max. | 3.4 ± 0.7 | 31.7 ± 2.2 | < 289 |
| | Avg. | 0.9 ± 1.4 | 11.6 ± 11.5 | 27 ± 124 |
| HS | N | 4 | 4 | 4 |
| | Max. | 11.7 ± 1.1 | 15.4 ± 1.7 | 293 ± 188 |
| | Avg. | 3.7 ± 4.5 | 7.8 ± 4.6 | 102 ± 122 |
| HT-E | N | 4 | 4 | 4 |
| | Max. | < 0.8 | 6.7 ± 1.5 | < 361 |
| | Avg. | 0.2 ± 0.2 | 3.8 ± 1.9 | 123 ± 210 |
| HT-W | N | 4 | 4 | 4 |
| | Max. | 6.1 ± 1.0 | 51.3 ± 2.6 | < 361 |
| | Avg. | 1.8 ± 2.4 | 18.1± 19.5 | 13 ± 132 |
| **SDWA Limit** | | 15 | 50 | 20,000 |

Notes:
Figure 5-7 provides the locations of outfall/recharge basins.
All values reported with a 95% confidence interval.
Recharge basins HW, HX, and CSF were not sampled for radiological parameters in 2000.
N = Number of samples collected for analysis.
SWDA = Safe Drinking Water Act.

### 5.4.2 RECHARGE BASINS - NONRADIOLOGICAL ANALYSES

To determine the overall impact of the recharge basin discharges on the environment, the 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 the BNL Analytical Services 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. For VOCs, low concentrations of disinfection by-products were, as expected, routinely detected in several discharges including bromoform, chloroform, dibromochloromethane, and dichlorobromomethane. Concentrations ranged from nondetectable to a maximum of 2.6 µg/L. Sodium hypochlorite and bromine, used to control algae in cooling towers, were responsible for the formation of these compounds. Acetone was also detected sporadically in several samples across BNL at concentrations up to 20 µg/L . Acetone is commonly found as a contaminant in analytical laboratories and may be present due to its ability to evaporate in one area and then redissolve in water in another area of the laboratory.

The analytical data in Tables 5-5 and 5-6 show that most parameters, except for aluminum, iron, and lead, complied with the respective groundwater discharge or water quality standards. Aluminum and iron are natural components of soil and readily dissolve when water is acidified for sample preservation. Iron is present naturally in Long Island groundwater at concentrations that exceed the New York State groundwater effluent limit. The pH measured at several of the recharge basins was outside the groundwater effluent standard of 6.5 – 8.5 Standard Units. The pH of local groundwater and precipitation is lower than the standard, and

thus contributed to the low pH observations. The high pH observations are attributed to sodium hydroxide or calcium hydroxide additions to the domestic water system. Periodically the pH of the domestic water is greater than 8.5 due to chemical over addition.

Lead was measured in water samples collected from the discharge to Basin CSF at concentrations up to 105 µg/L. Additionally, vanadium and nickel were also detected at concentrations significantly higher than at other basins. Soil samples collected at this discharge location have historically exhibited high levels of lead and the other inorganics. See Chapter 6 for a discussion of soil sampling results. Due to the high levels in soils,

**Table 5-5. Water Quality Data for Onsite Recharge Basins (CY 2000).**

| Recharge Basin | | pH (SU) | Conductivity (µS/cm) | Temperature ( °C) | Chlorides (mg/L) | Sulfates (mg/L) | Nitrate as N* (mg/L) |
|---|---|---|---|---|---|---|---|
| HN | N | 16 | 6 | 16 | 4 | 4 | 4 |
| (RHIC) | Min. | 6.6 | 80 | 6.3 | 21.9 | 5.6 | < 1 |
| | Max. | 7.8 | 158 | 23.0 | 33 | 17 | < 1 |
| | Avg. | NA | 128 | 14.0 | 26.1 | 12.0 | < 1 |
| HO | N | 16 | 4 | 16 | 4 | 4 | 4 |
| (AGS/HFBR) | Min. | 6.5 | 141 | 5.0 | 16.4 | 9.2 | < 1 |
| | Max. | 8.1 | 151 | 24.7 | 22.1 | 11.2 | < 1 |
| | Avg. | NA | 144 | 11.5 | 20.0 | 10.5 | < 1 |
| HP | N | 7 | 4 | 7 | 4 | 4 | 4 |
| (BMRR) | Min. | 6.0 | 145 | 11.1 | 19.1 | 10.4 | < 1 |
| | Max. | 7.5 | 194 | 26.6 | 34.3 | 14.3 | < 1 |
| | Avg. | NA | 176 | 18.2 | 28.6 | 13.1 | < 1 |
| HS | N | 15 | 4 | 15 | 4 | 4 | 4 |
| (Stormwater) | Min. | 6.6 | 181 | 4.1 | 24.5 | 12.4 | < 1 |
| | Max. | 8.8 | 255 | 49.7 | 45.7 | 18.2 | 1.5 |
| | Avg. | NA | 217 | 14.2 | 36.6 | 15.5 | < 1 |
| HT-E | N | 14 | 4 | 14 | 4 | 4 | 4 |
| (AGS) | Min. | 6.9 | 138 | 5.7 | 17.6 | 11.2 | < 1 |
| | Max. | 8.3 | 200 | 22.7 | 23.7 | 12.5 | < 1 |
| | Avg. | NA | 158 | 17.3 | 20.6 | 11.9 | < 1 |
| HT-W | N | 17 | 3 | 17 | 4 | 4 | 4 |
| (LINAC) | Min. | 7.0 | 88 | 6.8 | 17.8 | 11.7 | < 1 |
| | Max. | 8.4 | 172 | 25.9 | 27.1 | 13.5 | < 1 |
| | Avg. | NA | 151 | 16.4 | 22.2 | 12.6 | < 1 |
| HW | N | 10 | 1 | 9 | 3 | 3 | 3 |
| (Weaver Road) | Min. | 6.4 | 79 | 5.6 | < 4 | < 4 | < 1 |
| | Max. | 7.9 | 79 | 22.4 | 33.7 | 8.6 | < 1 |
| | Avg. | NA | 79 | 13.4 | 13.9 | 4.8 | < 1 |
| CSF | N | 8 | 2 | 8 | 3 | 3 | 3 |
| (Stormwater) | Min. | 6.3 | 58 | 5.0 | < 4 | < 4 | < 1 |
| | Max. | 7.5 | 131 | 24.7 | 25.8 | 4.6 | < 1 |
| | Avg. | NA | 94.5 | 11.5 | 10.5 | < 4 | < 1 |
| **NYSDEC Effluent Standard** | | 6.5 - 8.5 | SNS | SNS | 500 | 500 | 10 |
| **Typical MDL** | | NA | 10 | NA | 4 | 4 | 1 |

Notes:
See Figure 5-7 for the locations of recharge basins.
Recharge Basin HX was not sampled for water quality parameters in 2000.
*Holding times for nitrate analyses are routinely exceeded
AGS/HFBR = Alternating Gradient Synchrotron/High Flux Beam Reactor
BMRR = Brookhaven Medical Research Reactor
CSF = Central Steam Facility
MDL = Minimum Detection Limit
N = No. of samples
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 Data for Onsite Recharge Basins (CY 2000).**

| Recharge Basin | 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 | Mo 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 | 4 | Min. | < 1.0 | 47.4 | < 3.0 | 21.9 | < 0.66 | < 1.1 | 0.2 | < 1.0 | 34.0 | 0.2 | < 0.2 | 7.8 | < 5.0 | 16.2 | 1.2 | 2.0 | < 0.88 | < 5 | < 0.66 | < 5.5 | 48.5 |
| (RHIC) | | Max. | < 1.0 | 3690.0 | 4.2 | 38.4 | < 0.66 | < 1.1 | 0.7 | 2.4 | 58.1 | 3.4 | 0.4 | 33.1 | < 5.0 | 29.2 | 2.9 | 8.3 | < 0.88 | 14.2 | < 0.66 | 8.3 | 278.7 |
| | | Avg. | < 1.0 | 1000.0 | < 3.0 | 28.0 | < 0.66 | < 1.1 | 0.4 | 1.4 | 46.6 | 1.0 | < 0.2 | 23.7 | < 5.0 | 23.5 | 1.8 | 4.5 | < 0.88 | 7.0 | < 0.66 | < 5.5 | 130.8 |
| HO | 4 | Min. | < 1.0 | 7.6 | < 3.0 | 7.1 | < 0.66 | < 1.1 | 0.1 | < 1.0 | 5.6 | 0.2 | < 0.2 | 7.7 | < 5.0 | 15.3 | < 1.1 | < 1.3 | < 0.88 | < 5 | < 0.66 | < 5.5 | 8.0 |
| (AGS/HFBR) | | Max. | 2.7 | 235.7 | < 3.0 | 25.2 | < 0.66 | < 1.1 | 0.7 | < 1.0 | 33.8 | 0.4 | < 0.2 | 102.5 | < 5.0 | 22.5 | 1.8 | 2.8 | < 0.88 | 12.7 | < 0.66 | < 5.5 | 61.6 |
| | | Avg. | < 1.0 | 85.7 | < 3.0 | 21.5 | < 0.66 | < 1.1 | 0.3 | < 1.0 | 20.0 | 0.3 | < 0.2 | 47.5 | < 5.0 | 18.6 | 1.2 | < 1.3 | < 0.88 | < 5 | < 0.66 | < 5.5 | 30.1 |
| HP | 3 | Min. | < 1.0 | 3.4 | < 3.0 | 37.7 | < 0.66 | < 1.1 | 0.2 | < 1.0 | 3.5 | < 0.075 | < 0.2 | 53.5 | < 5.0 | 18.1 | < 1.1 | < 1.3 | < 0.88 | < 5.0 | < 0.66 | < 5.5 | < 4.0 |
| (BMRR) | | Max. | < 1.0 | 328.7 | < 3.0 | 61.0 | < 0.66 | < 1.1 | 0.5 | < 1.0 | 7.5 | 1.0 | < 0.2 | 102.1 | < 5.0 | 19.8 | < 1.1 | < 1.3 | < 0.88 | < 5.0 | < 0.66 | < 5.5 | 36.4 |
| | | Avg. | < 1.0 | 112.8 | < 3.0 | 48.1 | < 0.66 | < 1.1 | 0.3 | < 1.0 | 4.9 | 0.4 | < 0.2 | 70.1 | < 5.0 | 18.9 | < 1.1 | < 1.3 | < 0.88 | < 5.0 | < 0.66 | < 5.5 | 15.0 |
| HS | 4 | Min. | < 1.0 | 11.2 | < 3.0 | 25.3 | < 0.66 | < 1.1 | < 0.12 | < 1.0 | 4.5 | < 0.075 | < 0.2 | 4.1 | < 5.0 | 22.8 | < 1.1 | < 1.3 | < 0.88 | < 5.0 | < 0.66 | < 5.5 | 5.0 |
| (Stormwater) | | Max. | < 1.0 | 599.4 | 5.0 | 44.5 | < 0.66 | < 1.1 | 0.2 | < 1.0 | 52.2 | 0.6 | < 0.2 | 10.0 | < 5.0 | 29.0 | 2.1 | 3.3 | 2.0 | 12.8 | < 0.66 | < 5.5 | 61.9 |
| | | Avg. | < 1.0 | 181.4 | < 3.0 | 34.1 | < 0.66 | < 1.1 | < 0.12 | < 1.0 | 22.1 | 0.2 | < 0.2 | 6.0 | < 5.0 | 25.5 | < 1.1 | < 1.3 | < 0.88 | < 5.0 | < 0.66 | < 5.5 | 29.4 |
| HT-E | 4 | Min. | < 1.0 | 7.6 | < 3.0 | 20.3 | < 0.66 | < 1.1 | < 0.12 | < 1.0 | 11.2 | < 0.075 | < 0.2 | < 2.0 | < 5.0 | 15.6 | < 1.1 | < 1.3 | < 0.88 | < 5.0 | < 0.66 | < 5.5 | 12.2 |
| (AGS) | | Max. | < 1.0 | 45.0 | 3.1 | 47.0 | < 0.66 | < 1.1 | 0.2 | 1.2 | 15.9 | 0.1 | 0.3 | 30.5 | < 5.0 | 28.6 | 1.9 | 2.9 | < 0.88 | 13.8 | < 0.66 | < 5.5 | 58.0 |
| | | Avg. | < 1.0 | 21.8 | < 3.0 | 28.0 | < 0.66 | < 1.1 | < 0.12 | < 1.0 | 14.4 | < 0.075 | < 0.2 | 12.6 | < 5.0 | 21.6 | < 1.1 | < 1.3 | < 0.88 | 6.8 | < 0.66 | < 5.5 | 26.0 |
| HT-W | 4 | Min. | < 1.0 | 7.2 | < 3.0 | 17.0 | < 0.66 | < 1.1 | < 0.12 | < 1.0 | 24.9 | < 0.075 | < 0.2 | < 2.0 | < 5.0 | 18.0 | < 1.1 | < 1.3 | < 0.88 | < 5.0 | < 0.66 | < 5.5 | 5.5 |
| (LINAC) | | Max. | < 1.0 | 18.8 | 4.2 | 22.9 | < 0.66 | < 1.1 | 0.3 | 2.0 | 35.0 | < 0.075 | < 0.2 | 19.7 | < 5.0 | 27.5 | < 1.1 | < 1.3 | < 0.88 | 13.4 | < 0.66 | < 5.5 | 25.0 |
| | | Avg. | < 1.0 | 13.3 | < 3.0 | 20.9 | < 0.66 | < 1.1 | < 0.12 | 1.0 | 31.7 | < 0.075 | < 0.2 | 9.5 | < 5.0 | 22.7 | < 1.1 | < 1.3 | < 0.88 | < 5.0 | < 0.66 | < 5.5 | 11.7 |
| HW | 3 | Min. | < 1.0 | 1049.4 | < 3.0 | 15.4 | < 0.66 | < 1.1 | 0.4 | 2.1 | 38.0 | 0.8 | < 0.2 | 12.9 | < 5.0 | 3.0 | 1.7 | 15.6 | < 0.88 | < 5.0 | < 0.66 | 7.2 | 34.3 |
| (Weaver Rd.) | | Max. | < 2.0 | 2312.0 | < 6 | 30.7 | < 1.32 | < 2.2 | 0.9 | 5.9 | 73.6 | 2.3 | < 0.2 | 28.5 | < 10.0 | 24.6 | 6.3 | 23.2 | < 1.76 | < 10.0 | < 1.32 | 13.2 | 67.1 |
| (Stormwater) | | Avg. | < 1.0 | 1660.1 | < 3.0 | 21.2 | < 0.66 | < 1.1 | 0.7 | 4.1 | 57.4 | 1.5 | < 0.2 | 20.6 | < 5.0 | 10.7 | 3.6 | 19.5 | < 0.88 | < 5.0 | < 0.66 | 9.4 | 46.5 |
| CSF | 3 | Min. | < 1.0 | 1848.8 | < 3.0 | 17.9 | < 0.66 | < 1.1 | 0.5 | 1.2 | 27.3 | 0.7 | < 0.2 | 15.1 | < 5.0 | 2.8 | 3.7 | 5.2 | < 0.88 | < 5.0 | < 0.66 | 13.6 | 14.8 |
| (Stormwater) | | Max. | 2.1 | 4720.0 | < 6.0 | 21.3 | < 0.66 | < 2.2 | 1.8 | 3.7 | 70.7 | 3.5 | 0.3 | 34.8 | < 10.0 | 15.0 | 21.1 | 105.9 | < 1.76 | < 10.0 | < 1.32 | 50.8 | 55.7 |
| | | Avg. | < 1.0 | 2808.0 | < 3.0 | 22.3 | < 0.66 | < 1.1 | 1.0 | 2.4 | 48.6 | 2.0 | < 0.2 | 24.6 | < 5.0 | 7.8 | 10.9 | 42.3 | < 0.88 | < 5.0 | < 0.66 | 30.8 | 30.1 |
| **NYSDEC Effluent Limitation or AWQS** | | | 50.0 | 2,000.0 | 50.0 | 2,000.0 | SNS | 10.0 | 5.0 | 100.0 | 1,000.0 | 0.6 | 1.4 | 600.0 | SNS | SNS | 200.0 | 50.0 | 6.0 | 20.0 | SNS | SNS | 5,000.0 |
| **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 | 5.0 | 1.0 | 1.1 | 1.3 | 0.9 | 5.0 | 0.7 | 5.5 | 4.0 |

Notes:
See Figure 5-7 for locations of Recharge Basins.
Recharge Basin HX was not sampled for metals during CY 2000.
AGS/HFBR=Alternating Gradient Synchrotron/High Flux Beam Reactor
AWQS=Ambient Water Quality Standard
BMRR=Brookhaven Medical Research Reactor
CSF=Central Steam Facility
MDL=Minimum Detection Limit.
NYSDEC=New State Department of Environmental Conservation
RHIC=Relativistic Heavy Ion Collider
SNS=Effluent Standard Not Specified

suspended particulates were the most likely cause of the elevated concentrations observed in the water collected from the CSF discharge.

#### 5.4.3 STORMWATER ASSESSMENT

With the exception of Recharge Basins HP and HX, all recharge basins receive stormwater runoff. At BNL, stormwater is managed by collecting runoff from paved surfaces, roofs, and other impermeable surfaces, and directing it to the recharge basins via underground piping and abovegrade vegetated swales. Recharge Basin HS receives the majority of the stormwater runoff from the central developed portion of the BNL site (all properties south of Cornell Avenue and east of Railroad Avenue). Basins HN and HT-E receive runoff from the AGS and portions of the RHIC complex; Basin HO receives runoff from the BGRR and HFBR areas. As previously indicated, Basins HW, CSF, and HWM receive only stormwater runoff.

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 soils.

### 5.5 PECONIC RIVER SURVEILLANCE

Several locations were monitored along the Peconic River to assess the overall water quality of the river and to assess the impact from BNL discharges. Sampling points along the Peconic River are identified in Figure 5-9. In total, ten stations are monitored: three upstream and seven downstream of the STP outfall. In addition, a sampling station along the Carmans River (HH) is also monitored as a control location. All locations are monitored for radiological and nonradiological parameters on a routine basis.

The sampling stations are located as follows.

- Downstream sampling stations:
  - HM-N, onsite and 0.5 miles (0.8 km) downstream of the STP outfall
  - HM-S, onsite (a typically dry tributary of the Peconic River)
  - HQ, onsite and 1.2 miles (1.9 km) downstream of the STP outfall
  - HA and HB, offsite and 3.1 miles (5.0 km) downstream of the STP outfall
  - HC, offsite and 4.3 miles (6.9 km) downstream of the STP outfall
  - HR, offsite and 13 miles (20.9 km) downstream of the STP outfall (in Riverhead)
- Upstream locations:
  - HE, onsite, located immediately upstream of the STP
  - HV, onsite, located just east of the 10'oclock Experimental Hall in the RHIC ring
  - HY, onsite, located just east of the William Floyd Parkway
- Control location
  - HH, Carmans River

#### 5.5.1 PECONIC RIVER - RADIOLOGICAL ANALYSES

Radionuclide measurements were performed on surface water samples collected from the Peconic River at all ten locations. Routine samples at Stations HM-N and HQ were collected three times per week, as flow permitted. Station HE was collected quarterly in 2000. Since February 1995, these three locations have been equipped with Parshall flumes that allow automated flow-proportional sampling and volume measurements. All other sites were sampled quarterly by collecting instantaneous grab samples, as flow allowed.

The radiological data from Peconic River surface water sampling in 2000 are summarized in Table 5-7. Radiological analysis of upstream water samples showed that gross alpha and beta activities were occasionally detected at low levels at all three locations. Location HY exhibited the highest concentrations of all three upstream locations. Since this is the location closest to the BNL site border, it is used as the representative background location for the Peconic River. The concentrations of gross alpha activity detected in samples collected at HY ranged from 0.4 ± 0.6 to 12.2 ± 1.4 pCi/L (0.015 ± 0.02 to 0.5 ± 0.05 Bq/L). The concentration of gross beta activity ranged from 2.7 ± 1.4 pCi/L to 31.7 ± 7.1 pCi/L (0.1 ± 0.05 to 1.2 ± 0.3 Bq/L). Samples collected downstream of the BNL STP discharge showed very similar concentrations of gross alpha and beta activity to the upstream locations, with the exception of a single sample collected at station HM-N in November. This one sample exhibited a gross alpha concentration of 92.8 ± 9.6 pCi/L (3.4 ± 0.4 Bq/L). Re-analysis of an equal sample aliquot confirmed the original result. Gamma

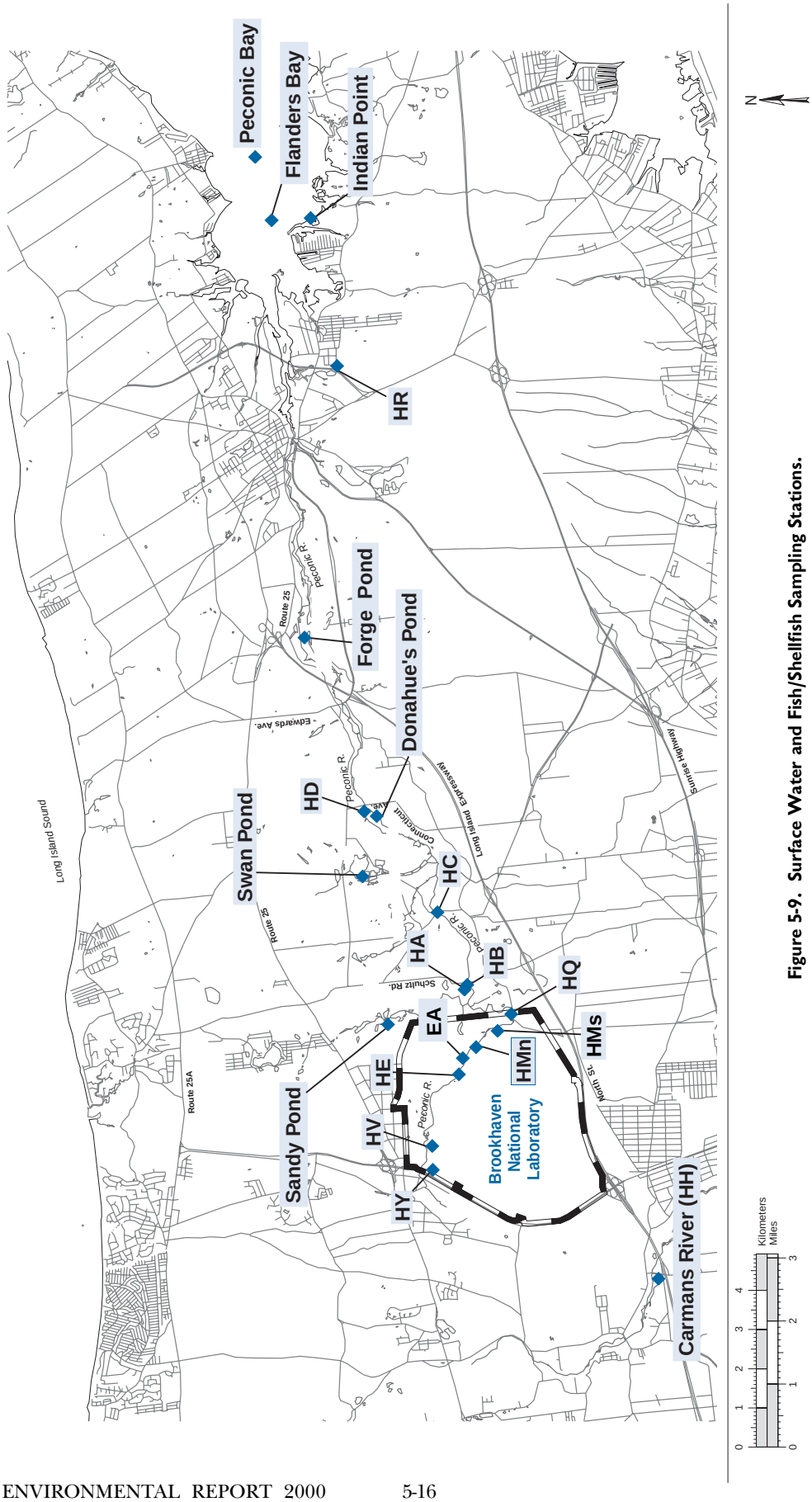


**Figure 5-9. Surface Water and Fish/Shellfish Sampling Stations.**

**Table 5-7. Radiological Results for Surface Water Samples Collected Along the Peconic and Carmans Rivers (CY 2000).**

| Sample Station | Geographic Location | | Gross Alpha (pCi/L) | Gross Beta (pCi/L) | Tritium (pCi/L) | Sr-90 (pCi/L) |
|---|---|---|---|---|---|---|
| HY | Peconic River (headwaters) onsite, east of the Wm. Floyd Pkwy. | N | 5.0 | 5.0 | 2 | NS |
| | | Max. | 12.2 ± 1.4 | 31.7 ± 7.1 | < 298 | |
| | | Avg. | 4.2 ± 3.7 | 14.3 ± 9.0 | 86 ± 68 | |
| HV | Peconic River (Headwaters) onsite, inside the RHIC ring | N | 3.0 | 3.0 | 2 | NS |
| | | Max. | 3.6 ± 0.7 | 5.8 ± 1.4 | < 315 | |
| | | Avg. | 2.0 ± 1.4 | 4.4 ± 2.2 | 1 ± 97 | |
| HE | Peconic River, upstream of STP Outfall | N | 4 | 4 | 4 | 4 |
| | | Max. | 2.8 ± 0.7 | 7.9 ± 1.6 | < 289 | 0.34 ± 0.01 |
| | | Avg. | 1.3 ± 1.8 | 5.3 ± 2.4 | 16 ± 130 | 0.30 ± 0.05 |
| HM-N | Peconic River, 0.4 mi from STP, onsite | N | 150 | 150 | 150 | 3 |
| | | Max. | 92.8 ± 9.6 | 37.7 ± 7.0 | 1350 ± 262 | < 0.17 |
| | | Avg. | 2.6 ± 1.2 | 8.6 ± 0.8 | 143 ± 25 | 0.03 ± 0.03 |
| HM-S | Peconic River tributary, onsite | N | 3 | 3 | 3 | 3 |
| | | Max. | 2.5 ± 0.7 | 4.9 ± 1.4 | < 315 | < 0.18 |
| | | Avg. | 1.3 ± 1.1 | 2.7 ± 2.1 | -25 ± 69 | 0.13 ± 0.01 |
| HQ[1] | Peconic River, BNL site boundary | N | 46 | 46 | 46 | 2 |
| | | Max. | 5.8 ± 2.7 | 42.5 ± 7.2 | 363 ± 207 | < 0.17 |
| | | Avg. | 2.1 ± 0.5 | 10.1 ± 2.2 | 93 ± 25 | 0.13 ± 0.04 |
| HA | Peconic River, offsite | N | 5 | 5 | 5 | NS |
| | | Max. | 2.4 ± 0.7 | 28.2 ± 2.1 | < 338 | |
| | | Avg. | 0.8 ± 0.7 | 9.6 ± 3.3 | -95 ± 1 | |
| HB | Peconic River, offsite | N | 5 | 5 | 5 | NS |
| | | Max. | 1.6 ± 0.8 | 4.9 ± 1.4 | < 338 | |
| | | Avg. | 0.8 ± 0.6 | 2.8 ± 1.2 | -62 ± 103 | |
| HC | Peconic River, offsite | N | 4 | 4 | 4 | NS |
| | | Max. | 13.6 ± 1.4 | 6.8 ± 1.6 | < 338 | |
| | | Avg. | 4.4 ± 5.4 | 4.6 ± 1.7 | -93 ± 111 | |
| HR | Peconic River, offsite, Riverhead | N | 4 | 4 | 4 | NS |
| | | Max. | 2.6 ± 0.7 | 8.6 ± 1.6 | < 338 | |
| | | Avg. | 1.0 ± 1.0 | 4.0 ± 2.7 | -64 ± 99 | |
| HH | Carmans River (Control Location) | N | 4 | 4 | 4 | NS |
| | | Max. | 2.7 ± 1.4 | 9.3 ± 2.0 | < 338 | |
| | | Avg. | 0.8 ± 0.7 | 4.1 ± 2.9 | -94 ± 103 | |
| **SDWA Limit** | | | 15.0 | 50.0 | 20,000 | 8 |

Notes:
See Figure 5-9 for sample station locations.
No gamma-emitting anthropogenic radionuclides were detected in Peconic River water samples in 2000.
All values shown with 95% confidence interval.
Negative numbers occur when the measured value is lower than background.
For Stations HM-N and HQ, Sr-90 analysis results based on composite samples, all others collected as grab samples.
N = Number of samples analyzed
NS = Not Sampled for this analyte
SDWA = Safe Drinking Water Act
[1]Station HQ was dry for 8 months during 2000.

analysis did not identify a radionuclide capable of producing such a result. Since there was no detection of gross alpha activity at this level in the STP influent or effluent, and there were no detections at stations farther downstream or in subsequent samples collected from this station, the result appears to be an analytical anomaly. No gamma emitting radionuclides attributable to BNL operations were detected either upstream or downstream of the STP.

Tritium analysis of water samples collected upstream and downstream from the STP discharge showed only detectable levels at

Station HM-N. The maximum concentration (1,350 ± 262 pCi/L [50.0 ± 9.7 Bq/L]) was consistent with the levels discharged from the BNL STP.

Monitoring for strontium-90 was performed at stations HE, HM-N and HQ. Trace levels were found at all locations, the highest at Station HE. Strontium-90 was detected at Station HE at a maximum concentration of 0.34 ± 0.01 pCi/L (0.01 ± 0.0004 Bq/L), which is approximately 4% of the drinking water standard and one-third the levels detected in 1999.

### 5.5.2 PECONIC RIVER - NONRADIOLOGICAL ANALYSES

The inorganic analytical data for the Peconic River and Carmans River samples are summarized in Tables 5-8 and 5-9. Samples collected in 2000 were analyzed for water quality parameters (pH, temperature, conductivity, and dissolved oxygen), anions (chlorides, sulfates, and nitrates), metals, and VOCs.

No VOCs were routinely detected in river water samples above the MDLs, although low concentrations were reported for acetone (5 µg/L or less) and 2-butanone (2 µg/L or less) at several locations. Due to the level of detection, the ubiquitous nature of these compounds in the analytical laboratory, and similar levels of detection in samples collected on the same day, the presence of these compounds is questionable. Trace concentrations of 1,1,1-trichloroethane and 1,1-dichloroethylene were detected in water samples collected at Station HR. Due to the location of this station (Riverhead) and the absence of these compounds at locations closer to BNL, these compounds are not expected to be the result of BNL operations, but may be the result of roadway runoff or other offsite sources. Methylene chloride was detected at 3.3 µg/L in a single sample collected at Station HM-N. This is below the groundwater standard of 5 µg/L and much lower than the Peconic surface water standard of 50 µg/L. No other organic compounds were detected upstream or downstream of the STP discharge.

Comparison of Peconic River water quality data collected upstream and downstream showed that water quality parameters were consistent throughout the river system. These data were also consistent with the Carmans River control location (HH). Chlorides, 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.

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 the spring rains mix with the decaying matter, these acids decrease the already low pH of precipitation, resulting in a pH of as low as 3.0 Standard Units. A discussion of precipitation monitoring is provided in Chapter 6 of this report.

Ambient water quality standards for metallic elements are based upon their solubility state. Certain metals are only biologically available to aquatic organisms if they are in a dissolved or ionic state, while others are toxic in any form (i.e., dissolved and particulate combined). In 2000, the BNL monitoring program assessed water samples for both the dissolved and particulate form. Dissolved concentrations were determined by first filtering the samples prior to acidic preservation and analysis. Examination of the metals data showed that aluminum, copper, lead, mercury, iron, silver, and zinc were present in concentrations which exceeded ambient water quality standards at upstream, downstream and, in some instances, the Carmans River stations. Aluminum, silver, and iron were at the highest concentrations in water samples collected upstream from the STP. Copper, zinc, lead, and mercury were highest in water samples collected immediately downstream at Station HM-N. These elements were routinely detected in the STP discharge and, with the exception of mercury, were detected in the STP discharge in similar concentrations. All levels were less than SPDES permitted effluent limits. Selenium was detected in all samples collected in July 2000. However, the laboratory method blank also tested positive for selenium at similar concentrations. The presence of selenium is most likely due to method blank contamination and not representative of river water quality. Filtration of samples did not influence the concentration of metals in the samples; however, a direct comparison cannot be made since the filtered and unfiltered samples were collected at different times

**Table 5-8. Water Quality Analytical Results for Surface Water Samples Collected Along the Peconic and Carmans Rivers (CY 2000).**

| Sample Station | Geographic Location | | pH (SU) | Conductivity (µS/cm) | Temp. (deg. C) | Dissolved Oxygen (mg/L) | Chlorides (mg/L) | Sulfates (mg/L) | Nitrates as N (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| HY | Peconic River (headwaters) onsite, east of Wm. Floyd Pkwy. | N | 5.0 | 5 | 5.0 | 5.0 | 2.0 | 2.0 | 2.0 |
| | | Min. | 4.3 | 30 | 5.7 | 6.9 | < 4.0 | < 4.0 | < 1.0 |
| | | Max. | 7.4 | 810 | 17.5 | 15.6 | < 4.0 | < 4.0 | < 1.0 |
| | | Avg. | NA | 202 | 11.7 | 10.7 | < 4.0 | < 4.0 | < 1.0 |
| HV | Peconic River (headwaters) onsite, inside the RHIC ring | N | 3.0 | 3 | 3.0 | 3.0 | NS | NS | NS |
| | | Min. | 4.2 | 7 | 3.7 | 8.6 | | | |
| | | Max. | 6.1 | 200 | 11.3 | 12.2 | | | |
| | | Avg. | NA | 91 | 8.7 | 10.3 | | | |
| HE | Peconic River upstream of STP Outfall | N | 4.0 | 4 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| | | Min. | 5.6 | 61 | 0.7 | 3.6 | 7.3 | 4.8 | < 1.0 |
| | | Max. | 6.0 | 72 | 20.2 | 8.3 | 9.4 | 7.7 | < 1.0 |
| | | Avg. | NA | 66 | 11.0 | 6.1 | 8.1 | 6.5 | < 1.0 |
| HM-N | Peconic River 0.4 mi from STP, onsite | N | 157.0 | 157 | 157.0 | 156.0 | 11.0 | 11.0 | 11.0 |
| | | Min. | 5.3 | 19 | 0.1 | 4.8 | 11.8 | 7.7 | 1.6 |
| | | Max. | 6.9 | 463 | 23.9 | 14.0 | 70.8 | 17.0 | 6.6 |
| | | Avg. | NA | 206 | 12.4 | 8.1 | 29.4 | 12.7 | 4.1 |
| HM-S | Peconic River tributary, onsite | N | 3.0 | 3 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| | | Min. | 3.6 | 61 | 5.8 | 7.6 | 5.0 | < 4.0 | < 1.0 |
| | | Max. | 5.8 | 89 | 10.7 | 8.0 | 5.9 | 5.0 | < 1.0 |
| | | Avg. | NA | 77 | 8.9 | 7.7 | 5.6 | 1.7 | < 1.0 |
| HQ | Peconic River BNL site boundary | N | 48.0 | 48 | 48.0 | 48.0 | 5.0 | 5.0 | 5.0 |
| | | Min. | 5.8 | 48 | 9.1 | 0.5 | 8.5 | 5.3 | < 1.0 |
| | | Max. | 7.9 | 191 | 25.4 | 20.5 | 81.0 | 37.7 | < 1.0 |
| | | Avg. | NA | 153 | 18.1 | 4.4 | 29.4 | 14.3 | < 1.0 |
| HA | Peconic River offsite | N | 5.0 | 5 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| | | Min. | 6.0 | 42 | 1.2 | 5.0 | 6.8 | < 4.0 | < 1.0 |
| | | Max. | 6.4 | 52 | 26.1 | 13.3 | 7.6 | 5.0 | < 1.0 |
| | | Avg. | NA | 47 | 10.7 | 9.9 | 7.3 | 2.8 | < 1.0 |
| HB | Peconic River offsite | N | 5.0 | 5 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| | | Min. | 6.3 | 51 | 0.8 | 3.9 | 8.2 | < 4.0 | < 1.0 |
| | | Max. | 6.5 | 67 | 23.2 | 13.8 | 9.7 | 4.9 | < 1.0 |
| | | Avg. | NA | 56 | 12.1 | 8.3 | 8.5 | 2.9 | < 1.0 |
| HC | Peconic River offsite | N | 4.0 | 4 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| | | Min. | 6.6 | 55 | 3.6 | 7.6 | 9.1 | 4.1 | < 1.0 |
| | | Max. | 6.8 | 88 | 27.5 | 11.4 | 12.1 | 7.8 | < 1.0 |
| | | Avg. | NA | 68 | 14.4 | 10.3 | 10.2 | 6.0 | < 1.0 |
| HR | Peconic River offsite, Riverhead | N | 4.0 | 4 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| | | Min. | 6.3 | 104 | 3.7 | 9.7 | 14.5 | 9.3 | < 1.0 |
| | | Max. | 7.7 | 155 | 27.9 | 12.4 | 18.0 | 10.5 | < 1.0 |
| | | Avg. | NA | 134 | 15.3 | 11.4 | 16.0 | 10.2 | < 1.0 |
| HH | Carmans River (Control Location) | N | 4.0 | 4 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| | | Min. | 6.4 | 148 | 4.0 | 9.5 | 23.7 | 9.4 | 1.1 |
| | | Max. | 6.9 | 170 | 23.7 | 13.0 | 26.7 | 12.1 | 1.7 |
| | | Avg. | NA | 158 | 14.1 | 11.6 | 24.8 | 11.3 | 1.5 |
| **NYS AWQS[a]** | | | 6.5 - 8.5 | SNS | SNS | SNS | 250.0 | 250.0 | 10.0 |
| **Typical MDL** | | | NA | 10 | NA | NA | 4.0 | 4.0 | 1.0 |

Notes:
See Figure 5-9 for sample station locations.
N = No. of samples
NA = Not Applicable
NS = Not Sampled
MDL = Minimum Detection Limit
RHIC = Relativistic Heavy Ion Collider
SNS = Standard Not Specified
STP = Sewage Treatment Plant
[a]Since there are no Class C Surface Water Ambient Water Quality Standards (AWQS) for these compounds, the AWQS for groundwater is provided, if specified.
Su = Standard Unit

**Table 5-9. Metals Analytical Results for Surface Water Samples Collected Along the Peconic and Carmans Rivers (CY 2000).**

| River | 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 | Mo µg/L | Ni µg/L | Na mg/L | Pb µg/L | Sb µg/L | Se* µg/L | Tl µg/L | V µg/L | Zn µg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Peconic** | HY (Total) | 1 | Value | < 2.0 | 965.2 | < 3.0 | 24.1 | < 0.7 | < 2.2 | 0.7 | 2 | 38.1 | 0.5 | < 0.2 | 53.1 | < 10 | 3.3 | 1.6 | 8.9 | 1.8 | < 10 | < 1.3 | < 11 | 27.3 |
| | HY (Filtered) | 1 | Value | < 1.0 | 100 | < 3.0 | 4 | < 0.7 | < 2.2 | 0.1 | < 1 | 2.8 | NR | NR | 5.7 | < 5 | < 1.1 | NR | < 1.3 | < 0.9 | < 5 | < 0.7 | < 5.5 | 9.3 |
| | HE (Total) | 2 | Min. | < 1.0 | 194.1 | 3.1 | 14.2 | < 0.7 | < 1.1 | 0.5 | < 1.0 | < 2.0 | 0.4 | < 0.2 | 59.7 | < 5.0 | < 1.1 | 5.1 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | 10.1 |
| | | | Max. | < 1.0 | 257 | 3.4 | 43.5 | < 0.7 | < 1.1 | 0.9 | < 1.0 | 2.8 | 0.5 | NR | 122 | < 5.0 | 1.1 | 5.3 | < 1.3 | < 0.9 | 13.7 | < 0.7 | < 5.5 | 20.9 |
| | HE (Filtered) | 2 | Min. | < 1 | 13 | 5.6 | 32.4 | < 0.7 | < 1.1 | 0.6 | 1.5 | 6.9 | 0.9 | 0.2 | 144 | < 5 | < 1.1 | 5.9 | < 1.3 | < 0.9 | < 10.0 | < 0.7 | < 1.1 | 23.9 |
| | | | Max. | 79 | 580.8 | 6 | 67.7 | < 1.3 | < 2.2 | 1.3 | < 2.0 | 30.9 | 3.2 | 0.3 | 226 | < 10 | 3.1 | 6.3 | 6.3 | < 1.8 | 25.8 | < 1.3 | < 5.5 | 56.2 |
| | HM-N | 10 | Min. | < 1.0 | 17.5 | < 3.0 | 3.9 | < 0.7 | < 1.1 | < 0.1 | < 1.0 | < 2 | < 0.08 | < 0.2 | < 2 | < 5.0 | < 1.1 | 10.4 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | < 4.0 |
| | | | Max. | < 10.0 | 338.7 | 5.4 | 31.6 | < 0.7 | < 11 | < 1.2 | 14 | 93.3 | 0.7 | 1.4 | 98 | < 50 | < 11 | 40.1 | 13.2 | < 8.8 | 25.9 | < 6.6 | 8.8 | 87.5 |
| | | | Avg. | 1.7 | 113.8 | < 3.0 | 18.1 | < 0.7 | < 1.1 | 0.6 | 2.3 | 43.9 | 0.3 | 0.2 | 17.8 | < 5.0 | 4.1 | 22 | 2.2 | < 0.9 | 11.6 | < 0.7 | < 5.5 | 47.9 |
| | HM-N (Filtered) | | | < 1.0 | 15.5 | < 3.0 | 18.9 | < 0.7 | < 1.1 | 0.3 | < 1.0 | 31.6 | 0.08 | NR | 2.3 | < 5.0 | 5.3 | 24.1 | < 1.3 | < 0.9 | < 5 | < 0.7 | < 5.5 | 51.5 |
| | HM-S | 2 | Min. | < 1.0 | 630.2 | < 3 | 11.1 | < 0.7 | < 1.1 | 0.1 | 1 | 45.6 | 0.27 | < 0.2 | 26.5 | < 5.0 | < 1.1 | 1.6 | 1.8 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | < 4 |
| | | | Max. | < 1.0 | 734.4 | 7.2 | 14.9 | < 0.7 | < 1.1 | 0.2 | 1 | 59.4 | 0.32 | 0.4 | 35.6 | < 5.0 | 5.7 | 3.5 | 3.8 | < 0.9 | 17.1 | < 0.7 | < 5.5 | 40 |
| | HQ | 4 | Min. | < 1.0 | 22.2 | < 3.0 | 12.3 | < 0.7 | < 1.1 | 0.2 | < 1.0 | 6.5 | 0.1 | < 0.2 | 3.7 | < 5.0 | 2.1 | 7.1 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | 7 |
| | | | Max. | 1.4 | 485.6 | 7.9 | 15.9 | < 0.7 | < 1.1 | 0.4 | 1.8 | 23.6 | 0.4 | 0.3 | 20.7 | < 5.0 | 4.1 | 24 | 2.7 | < 0.9 | 17.9 | < 0.7 | 6 | 10.3 |
| | | | Avg. | < 1.0 | 153.2 | < 3.0 | 13.4 | < 0.7 | < 1.1 | 0.3 | < 1.0 | 13 | 0.2 | < 0.2 | 12.2 | < 5.0 | 3 | 15.8 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | 8.7 |
| | HA (Total) | 2 | Min. | < 1.0 | 83.2 | < 3.0 | 10.4 | < 0.7 | < 1.1 | 0.13 | 1 | 2 | 0.5 | < 0.2 | 21.1 | < 5.0 | < 1.1 | 3.8 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | < 4.0 |
| | | | Max. | 30 | 92.4 | < 3.0 | 13.2 | < 0.7 | < 1.1 | 0.17 | 1 | 42.9 | 0.8 | < 0.2 | 47.4 | < 5.0 | < 1.1 | 4.9 | 1.7 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | 16.2 |
| | HA (Filtered) | 2 | Min. | < 1.0 | 46.1 | < 3.0 | 10.1 | < 0.7 | < 1.1 | 0.2 | < 1.0 | < 2.0 | 0.6 | 0.2 | 30.1 | < 5.0 | < 1.1 | 4.7 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | 4.5 |
| | | | Max. | < 1.0 | 52.7 | 3.4 | 12.6 | < 0.7 | < 1.1 | 0.5 | < 1.0 | 4.2 | 1 | < 0.2 | 75.5 | < 5.0 | < 1.1 | 5.2 | < 1.3 | < 0.9 | 12.4 | < 0.7 | < 5.5 | 5 |
| | HB (Total) | 2 | Min. | < 1.0 | 52.1 | < 3.0 | 12.6 | < 0.7 | < 1.1 | 0.13 | 1 | < 2.0 | 0.8 | < 0.2 | 25.5 | < 5.0 | < 1.1 | 5.2 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | 9.8 |
| | | | Max. | < 1.0 | 68.5 | < 3.0 | 14.6 | < 0.7 | < 1.1 | 0.3 | 1 | 46.6 | 1.4 | < 0.2 | 76.9 | < 5.0 | < 1.1 | 5.4 | 1.5 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | 16.8 |
| | HB (Filtered) | 2 | Min. | < 1.0 | 28.9 | < 3.0 | 9.8 | < 0.7 | < 1.1 | < 0.1 | < 1.0 | < 2.0 | 0.9 | < 0.2 | 28 | < 5.0 | < 1.1 | 5.2 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | <4.0 |
| | | | Max. | < 1.0 | 33.8 | 4.7 | 12.2 | < 0.7 | < 1.1 | 0.5 | < 1.0 | < 2.0 | 1.7 | 0.4 | 25.5 | < 5.0 | < 1.1 | 5.7 | < 1.3 | < 0.9 | 13.9 | < 0.7 | < 5.5 | 15.8 |
| | HC (Total) | 2 | Min. | < 1.0 | 44.1 | < 3.0 | 15 | < 0.7 | < 1.1 | < 0.1 | 1 | < 2.0 | 0.8 | < 0.2 | 33.5 | < 5.0 | < 1.1 | 6.2 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | 9.6 |
| | | | Max. | < 1.0 | 90.4 | < 3.0 | 18.5 | < 0.7 | < 1.1 | 0.2 | 1 | 110 | 0.8 | 0.2 | 122 | < 5.0 | < 1.1 | 7.4 | 2.2 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | 11 |
| | HC (Filtered) | 2 | Min. | < 1.0 | 38 | < 3.0 | 11.8 | < 0.7 | < 1.1 | 0.1 | < 1.0 | < 2.0 | 0.8 | < 0.2 | 21.6 | < 5.0 | < 1.1 | 6 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | 13.5 |
| | | | Max. | 22 | 46.3 | 4 | 15.2 | < 0.7 | < 1.1 | 0.3 | < 1.0 | < 2.0 | 1.9 | 0.5 | 41.8 | < 5.0 | < 1.1 | 6.8 | < 1.3 | < 0.9 | 13 | < 0.7 | < 5.5 | 13.9 |
| | HR (Total) | 2 | Min. | < 1.0 | 40.6 | < 3.0 | 11.3 | < 0.7 | < 1.1 | 0.2 | 1 | 2 | 0.7 | < 0.2 | 29.8 | < 5.0 | < 1.1 | 9.9 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | < 4.0 |
| | | | Max. | 15.9 | 736.2 | < 3.0 | 24.3 | < 0.7 | < 1.1 | 0.2 | 1 | 7.7 | 0.8 | < 0.2 | 142 | < 5.0 | < 1.1 | 11.4 | 1.5 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | < 4.0 |
| | HR (Filtered) | 2 | Min. | < 1.0 | 15.8 | < 3.0 | 17.4 | < 0.7 | < 1.1 | 0.1 | < 1.0 | < 2.0 | 0.3 | 0.2 | 35 | < 5.0 | < 1.1 | 10.7 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | 5.8 |
| | | | Max. | < 1.0 | 28.6 | 3.7 | 18.8 | < 0.7 | < 1.1 | 0.2 | < 1.0 | 2 | 0.9 | 0.3 | 50.6 | < 5.0 | < 1.1 | 11.3 | < 1.3 | < 0.9 | 13.7 | < 0.7 | < 5.5 | 48.2 |
| **Carmans** (Control Location) | HH (Total) | 1 | Value | < 1.0 | 9.3 | < 3.0 | 27.3 | < 0.7 | < 1.1 | 0.1 | < 1.0 | 2.4 | 0.1 | < 0.2 | 25.2 | < 5.0 | < 1.1 | 17.1 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | <4.0 |
| | HH (Filtered) | 2 | Min. | < 1.0 | 10.9 | < 3.0 | 32.6 | < 0.7 | < 1.1 | 0.2 | < 1.0 | 2.3 | 0.3 | < 0.2 | 78.8 | < 5.0 | < 1.1 | 16.8 | < 1.3 | < 0.9 | < 5.0 | < 0.7 | < 5.5 | < 4.0 |
| | | | Max. | < 1.0 | 78.2 | 3.5 | 34.7 | < 0.7 | < 1.1 | 0.4 | 1 | 2.4 | 0.5 | < 0.2 | 96.2 | < 5.0 | < 1.1 | 17.1 | < 1.3 | < 0.9 | 12.8 | < 0.7 | < 5.5 | < 4.0 |
| **NYSDEC AWQS** | | | | 0.1 | 100 | 150 | SNS | 11 | 1.1 | 5 | 34 | 4 | 0.3 | 0.2 | SNS | SNS | 23 | SNS | 0.1 | SNS | 4.6 | 8 | 14 | 37 |
| **Solubility State** | | | | I | I | D | | AS | D | AS | D | D | AS | D | | D | | D | D | AS | AS | D | | |
| **Typical MDL** | | | | 1 | 2.2 | 3 | 1.8 | 0.66 | 1.1 | 0.12 | 1 | 2 | 0.075 | 0.2 | 2 | 5 | 1.1 | 1 | 1.3 | 0.88 | 5 | 0.66 | 5.5 | 4 |

Notes:
See Figure 5-9 for sample station locations.
Surface water location HV was not sampled for metals in 2000
*The concentration of selenium detected in several samples analyzed in July are estimated due to blank contamination. Analysis of the method blank showed detectable levels of selenium very similar to those found in the samples.
AS = Acid Soluble
D = Dissolved
I = Ionic
MDL = Minimum Detection Limit
N = No. of Samples
NYSDEC AWQS=New York State Department of Environmental Conservation Ambient Water Quality Standard for Class C Surface Water
SNS = Standard Not Specified for these elements for Class C waters

within the year. Filtration of samples will be done again in 2001, and samples will be split at the time of collection with one-half filtered prior to acidic preservation and analysis to allow better comparison of dissolved and particulate levels of metals.

REFERENCES

BNL 2000, *Brookhaven National Laboratory Environmental Monitoring Plan 2000*, BNL-52584. Brookhaven National Laboratory, Upton, New York. March 2000.

DOE Order 5400.5. 1990. *Radiation Protection of the Public and the Environment.* U.S. Department of Energy, Washington, D.C. Change 2: 1-7-93.

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Chapter 6

# Natural and Cultural Resources

Brookhaven National Laboratory (BNL) has a wildlife management program to protect and manage flora and fauna and their habitats. The Laboratory's wildlife management strategy is based on an understanding of the resources onsite, ensuring compliance with applicable regulations, protecting and monitoring the ecosystem, conducting research, and communicating with staff and the public. BNL focuses on protection of New York State threatened and endangered species, as well as the role of BNL within the greater Long Island Central Pine Barrens ecosystem. Monitoring to determine whether current or historical activities have impacted wildlife is also part of this program. In 2000, deer and fish sampling results were consistent with previous years. Local farm grown produce and vegetables grown in the new BNL garden plot continue to support historical analysis that there is no Laboratory-generated radionuclides in farm produce. Vegetation monitoring did not indicate any radiological contamination above background levels. Goose fecal analysis indicates that geese may be concentrating low levels of cesium-137 in their droppings. Basin sediment and soil sampling shows no indication of contaminants above what has been observed in the past, with the exception of some higher levels of heavy metals detected at the Central Steam Facility. In 2000, BNL moved forward with its Cultural Resources Management Program by establishing a work plan for developing a Cultural Resources Management Plan. Work progressed on the development of a history video on the Brookhaven Graphite Research Reactor Complex which was determined to be eligible for inclusion on the National Register of Historic Places. Additionally, work was completed on a building survey to determine the potential historic value of BNL's buildings in accordance with the requirements of Section 110 of the National Historic Preservation Act.

## 6.1 WILDLIFE MANAGEMENT PROGRAM

The purpose of the wildlife management program at BNL is to promote stewardship of the natural resources found at the Laboratory, as well as to integrate natural resource protection with the Laboratory's mission. In 1998, BNL developed a Wildlife Management Plan that describes the program strategy, elements, and planned activities. This plan was updated in 1999 to incorporate comments from the U.S. Environmental Protection Agency (EPA) and the New York State Department of Environmental Conservation (NYSDEC) (Naidu 1999). The plan and related natural resources information about the Laboratory can be found at the Environmental Services Division website at <http://www.bnl.gov/wildlife/>. The program elements and some of the associated activities are summarized in this chapter.

### 6.1.1 IDENTIFICATION AND MAPPING OF NATURAL RESOURCES

An understanding of the environmental baseline is the starting point for wildlife management planning. The Central Pine Barrens Commission conducted a natural resources inventory of the BNL site based on data collected from 1970 to 1990. This mapping process has identified environmentally sensitive areas and significant wildlife communities. BNL is in the process of updating this inventory.

As noted in Chapter 1, a wide variety of vegetation, birds, reptiles, amphibians, and mammals reside onsite at BNL. The only New York State endangered species that inhabits BNL property is the tiger salamander (*Ambystoma t. tigrinum*) (see Figure 6-1). Three New York State threatened species have been identified: the banded sunfish (*Enneacanthus obesus*) (see Figure 6-2), the swamp darter (*Etheostoma fusiforme*) (see Figure 6-3), and the stiff goldenrod (*Solidago rigida*), a plant. In addition, several species that inhabit the BNL site, or visit during migration, are listed as "rare," "species of special concern," or "exploitably vulnerable" (see Table 6-1).

### 6.1.2 HABITAT PROTECTION AND ENHANCEMENT

Activities to eliminate or minimize negative impacts 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. Access to critical habitats is restricted. A map of tiger salamander breeding locations is maintained and reviewed when new projects are proposed to ensure that the projects do not negatively affect the breeding areas. The map is limited in distribution in order to protect the tiger salamander from being exploited by collectors and the pet trade. In some cases, habitats are enhanced to improve survival or increase populations. Routine activities (e.g., road maintenance) that are not expected to impact habitats are allowed to proceed.

**Figure 6-1. Tiger Salamander** ***(Ambystoma t. tigrinum)*****.**

**Figure 6-2. Banded Sunfish** ***(Enneacanthus obesus)*****.** This fish was released immediately after the picture was taken.

**Figure 6-3. Swamp Darter (*Etheostoma fusiforme*).** This fish was released immediately after the picture was taken.

Efforts to protect the tiger salamander include determining when adult salamanders are migrating toward breeding locations, when

**Table 6-1. New York State Threatened, Endangered, and Species of Special Concern.**

| Common Name | Scientific Name | State Status |
|---|---|---|
| **Fish** | | |
| Banded sunfish | *Enneacanthus obesus* | T |
| Swamp darter | *Etheostoma fusiforme* | T |
| **Amphibians** | | |
| Eastern tiger salamander | *Ambystoma tigrinum tigrinum* | E |
| Marbled salamander | *Ambystoma opacum* | SC |
| **Reptiles** | | |
| Spotted turtle | *Clemmys guttata* | SC |
| Eastern box turtle | *Terrapene carolina* | SC |
| Eastern hognose snake | *Heterodon platyrhinos* | SC |
| **Birds (nesting or common)** | | |
| Horned lark | *Eremophila alpestris* | SC |
| Whip-poor-will | *Caprimulgus vociferus* | SC |
| Vesper sparrow | *Pooecetes gramineus* | SC |
| Grasshopper sparrow | *Ammodramus savannarum* | SC |
| **Plants** | | |
| Butterfly weed | *Asclepias tuberosa* | V |
| Spotted wintergreen | *Chimaphila maculata* | V |
| Flowering dogwood | *Cornus florida* | V |
| Pink lady's slipper | *Cypripedium acaule* | V |
| Winterberry | *Ilex verticillata* | V |
| Sheep laurel | *Kalmia angustifolia* | V |
| Narrow-leafed bush clover | *Lespedeza augustifolia* | R |
| Ground pine | *Lycopodium obscurum* | V |
| Bayberry | *Myrica pensylvanica* | V |
| Cinnamon fern | *Osmunda cinnamomera* | V |
| Clayton's fern | *Osmunda claytoniana* | V |
| Royal fern | *Osmunda regalis* | V |
| Swamp azalea | *Rhododendron viscosum* | V |
| Stiff goldenrod | *Solidago rigida* | T |
| New York fern | *Thelypteris novaboracensis* | V |
| Marsh fern | *Thelypteris palustris* | V |
| Virginia chain-fern | *Woodwardia virginica* | 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

metamorphosis has been completed, and when juveniles are migrating after metamorphosis. During these times, construction and/or maintenance activities near tiger salamander habitats must be reviewed by BNL environmental protection staff, and every effort is made to minimize impacts. Water quality testing is conducted as part of the routine monitoring of water basins. These data are used to assess the quality of water prior to the breeding cycle. In cooperation with NYSDEC, limited habitat surveys were conducted in 2000. Comprehensive surveys of known and suspected tiger salamander habitats were completed with one additional breeding habitat identified, bringing the total known breeding locations to fifteen. All ponds identified as having egg masses during the spring surveys were surveyed again in June and July to determine reproductive success by presence of larval salamanders. Forty-eight larvae were seen, or captured and released, in four of the ponds in which egg masses were found. The results of these surveys will help determine the length of the breeding period and provide the information needed to determine a window for construction activities in and around the breeding areas. The information may also identify possible activities that could be affecting this species and changes in site use that are needed. The map of the breeding areas will be updated periodically to include any new observations.

As part of the tiger salamander surveys, incidental information is recorded on other amphibian species located in and around the tiger salamander habitat. Other species recorded include the northern redback salamander (*Plethodon c. cinereus),* spring peeper (*Pseudacris crucifer*), wood frog (*Rana sylvatica*), gray tree frog (*Hyla versicolor*), bullfrog (*Rana catesbiana*), green frog (*Rana clamitans*), and Fowler's toad (*Bufo fowleri*).

Banded sunfish protection efforts include ensuring that adequate flow of the 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. An additional banded sunfish population was identified in August 2000, and an additional New York threatened species, the swamp darter, was found co-located with banded sunfish at the

new location. Additional surveys of the river and other habitats onsite will be conducted in 2001 to monitor the population status of these two protected species.

BNL's Wildlife Management Plan also calls for habitat enhancement. In 1999, all readily available data were compiled to establish BNL's bird list. A total of 216 species have been identified at BNL since 1948, of which at least 85 are known to nest onsite. Some of these nesting birds have shown declines in their populations nationwide over the past 30 years. In 2000, the Laboratory established five permanent bird survey routes through various habitats and began routine monitoring of songbird populations. The results of these surveys are presented in Table 6-2. The surveys started in May 2000 and were carried out monthly through October 2000. Future songbird surveys will be conducted from March through October. The 2000 surveys resulted in the identification of 73 species during the year, of which 23 species were counted only once and are likely to be migrants stopping at BNL for a short period of time. The two most diverse transects pass near wetlands by the Biology Fields and the Peconic River. The three transects passing through the various forest types (white pine, moist pine barrens, and dry pine barrens) showed a less diverse bird community. In addition to songbird surveys, BNL also participates in the annual Christmas Bird Count conducted by the Audubon Society. BNL has participated in the count for several years, but the results have not been reported until now. The 2000 Christmas Bird Count for BNL was conducted on December 27 and resulted in the identification of 24 species of birds wintering at BNL.

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 nest site competition by the European starlings (*Sturnus vulgaris*) and house sparrows (*Passer domesticus*). In 2000, BNL installed 26 bluebird boxes around open grassland areas of the site to enhance the bluebird population. The boxes were monitored approximately every three weeks during the breeding season to determine use and nesting success. Bluebirds used seven of the installed boxes, with each pair producing at least one brood. House wrens (*Troglodytes aedon*) used five of the installed boxes. As part of BNL's efforts to improve habitat for this species, more than 40 bluebird boxes were presented as awards at Earth Day events in April and to Environmental Services Division employees. BNL intends to install up to 20 more boxes onsite in 2001, and present additional boxes as awards for the Site Environmental Report artwork contest and to employees providing an outstanding contribution to environmental protection of BNL.

#### 6.1.3 POPULATION MANAGEMENT

The Laboratory also monitors and manages other species populations as necessary to ensure that they are sustained and to control invasive species. For example, the Laboratory monitors populations of "species of interest," such as the wild turkey (*Meleagris gallopavo*). The onsite population of wild turkeys was estimated to be between 60 and 80 birds in 1999 and 200 birds by the end of 2000. The wild turkeys onsite are apparently doing well, as approximately one half of the estimated population is composed of juvenile birds. The large increase in the turkey population is likely due to a heavy crop of acorns that sustained the population through the winter of 1999-2000. Updated population reports are periodically sent to NYSDEC to assist with their population estimates. The population will continue to be monitored to determine reproductive success.

BNL is currently updating information on the onsite white-tailed deer (*Odocoileus virginianus*) population. Since there are no natural predators onsite and hunting is not permitted at BNL, there are no significant pressures on the population to migrate beyond their typical home range of approximately one mile. A 1992 study indicated that the population of deer onsite exceeded 700, or approximately 85 per square mile (2.59 square kilometers) (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 83 – 247 deer inhabiting the BNL property under normal circumstances. This number was likely seen in 1966 when the Laboratory reported an estimate of 267 deer onsite (Dwyer 1966). The current estimate, based on surveys conducted between November and December 2000, is 1,942 deer, or

**Table 6-2. Results of BNL Songbird Surveys Conducted During 2000.**

| Common Name | Scientific Name | Transect Name | | | | |
|---|---|---|---|---|---|---|
| | | Biology Fields | Peconic River | North Transect | East Trenches | South Transect |
| American Crow | *Corvus brachyrhynchos* | X | X | X | X | X |
| American Redstart | *Setophaga ruticilla* | X | | | | |
| American Robin | *Turdus migratorius* | X | X | X | X | X |
| Baltimore Oriole | *Icterus galbula* | X | | X | X | |
| Black-and-White Warbler | *Mniotilta varia* | X | X | X | | |
| Black-billed Cuckoo | *Coccyzus erythropthalmus* | X | X | X | | X |
| Black-capped Chickadee | *Poecile atricapillus* | X | X | X | X | X |
| Black-throated Green Warbler | *Dendroica virens* | | X | | | |
| Blue Jay | *Cyannocitta cristata* | X | X | X | X | X |
| Blue-winged Warbler | *Vermivora pinus* | | | | | X |
| Brown Creeper | *Certhia americana* | | X | | X | X |
| Brown Thrasher | *Toxostoma rufum* | X | X | | | |
| Brown-headed Cowbird | *Molothrus ater* | X | | | X | X |
| Canada Goose | *Branta canadensis* | | X | | X | |
| Carolina Wren | *Thryothorus ludovicianus* | | | | X | |
| Cedar Waxwing | *Bombycilla cedrorum* | X | X | | | |
| Chestnut-sided Warbler | *Dendroica pensylvanica* | | X | | | |
| Chipping Sparrow | *Spizella passerina* | X | X | X | X | X |
| Common Grackle | *Quiscalus quiscula* | X | X | X | X | X |
| Common Yellowthroat | *Geothlypis trichas* | X | X | | | |
| Dark-eyed Junco | *Junco hyemalis* | | X | | | |
| Downy Woodpecker | *Picoides pubescens* | X | | X | | X |
| Eastern Bluebird | *Sialia sialis* | X | | | | |
| Eastern Kingbird | *Tyranus tyranus* | | | | | X |
| Eastern Phoebe | *Sayornis phoebe* | | X | | | |
| Eastern Towhee | *Pipilo erythrophthalmus* | X | X | X | X | X |
| Eastern Wood Peewee | *Contopus virens* | X | X | X | X | X |
| European Starlings | *Sturnus vulgaris* | X | | | X | X |
| Field Sparrow | *Spizella pusilla* | X | | | | |
| Fox Sparrow | *Passerella iliaca* | | X | | | |
| Golden Eagle | *Aquila chrysaetos* | | | X | | |
| Golden-crowned Kinglet | *Regulus satrapa* | | X | | | |
| Goldfinch | *Carduelis tristis* | X | X | | X | |
| Grasshopper Sparrow | *Ammodramus savannarum* | X | | | | |
| Grey Catbird | *Dumetella carolinensis* | X | X | X | X | X |
| Herring Gull | *Larus argentatus* | X | | | | |
| Horned Lark | *Eremophila alpestris* | X | | | | |
| House Wren | *Troglodytes aedon* | X | X | | X | |
| Killdeer | *Charadrius vociferus* | | X | | | |
| Magnolia Warbler | *Dendroica magnolia* | X | X | | | |
| Mallard Duck | *Anas platyrhyncos* | | X | | | |
| Mourning Dove | *Zenaida macroura* | X | X | X | X | X |
| Nashville Warbler | *Vermivora ruficapilla* | X | X | | | |

*(continued on next page)*

**Table 6-2 Results of BNL Songbird Surveys Conducted During 2000** *(concluded)*.

| Common Name | Scientific Name | Transect Name | | | | |
|---|---|---|---|---|---|---|
| | | Biology Fields | Peconic River | North Transect | East Trenches | South Transect |
| Northern Bobwhite | *Colinus virginianus* | X | X | | X | X |
| Northern Cardinal | *Cardinalis cardinalis* | X | X | X | X | X |
| Northern Flicker | *Colaptes auratus* | X | X | X | X | X |
| Northern Mockingbird | *Mimus polyglottos* | X | | | | |
| Northern Parula | *Parula americana* | X | | | | |
| Northern Rough-winged Swallow | *Steligdopteryx serripennis* | | X | | | |
| Ovenbird | *Seiurus aurocapillus* | X | X | | X | |
| Pine Warbler | *Dendroica pinus* | | X | | X | X |
| Prairie Warbler | *Dendroica discolor* | X | | X | | |
| Red-bellied Woodpecker | *Melanerpes carolinus* | X | X | | | X |
| Red-breasted Nuthatch | *Sitta canadensis* | X | X | X | X | |
| Red-eyed Vireo | *Vireo olivaceus* | X | X | X | | X |
| Red-tailed Hawk | *Buteo jamaicensis* | X | | X | | |
| Red-winged Blackbird | *Agelaius phoeniceus* | X | X | | X | |
| Ring-billed Gull | *Larus delawarensis* | | | | | X |
| Rose-breasted Grossbeak | *Pheucticus ludovicianus* | X | | | | |
| Ruby-crowned Kinglet | *Regulus calendula* | X | X | | | |
| Scarlet Tanager | *Piranga olivacea* | X | | | | X |
| Sharp-shinned Hawk | *Accipiter striatus* | X | | | | |
| Tree Swallow | *Tachycineta bicolor* | X | | | | |
| Tufted Titmouse | *Baeolophus bicolor* | X | X | X | X | X |
| Veery | *Catharus fuscescens* | | X | | | X |
| White-breasted Nuthatch | *Sitta carolinensis* | | X | X | X | X |
| White-eyed Vireo | *Vireo griseus* | X | | | | |
| White-throated Sparrow | *Zonotrichia albicollis* | | X | | X | X |
| Wild Turkey | *Meleagris gallopavo* | | | | X | X |
| Wood Thrush | *Hylocichla mustelina* | X | X | | X | X |
| Yellow Warbler | *Dendroica petechia* | | X | | | |
| Yellow-bellied Sapsucker | *Sphyrapicus varius* | | X | | | |
| Yellow-billed Cuckoo | *Coccyzus americanus* | X | X | | X | X |
| **Totals** | | 50 | 48 | 23 | 31 | 32 |

approximately 236 deer per square mile. Age class comparisons from the 2000 population survey suggest that the deer population nearly doubled in 2000. This large increase in the deer population is likely due to an abundance of food available from the massive crop of acorns present and available during the 1999-2000 winter and what appeared to be an extended breeding season. In 2000, fawns were born starting in early April with late births occurring at the end of July and early August.

Overpopulation can affect both animal and human health (e.g., animal starvation, deer ticks transmit Lyme disease), decrease species diversity such as song birds (due to selective grazing and destruction of habitat), and can also result in increased property damage (grazing on ornamentals) and traffic accidents as the animals forage into developed areas for food. Reduction of property damage due to deer/vehicle collisions is one aspect considered in planning deer population manage-

ment. In 2000 there were 24 deer/vehicle collisions reported onsite. This is a dramatic increase over the four deer/vehicle collisions reported in 1999. The abrupt increase in deer/vehicle accidents began to occur in May 2000 as fawns and young deer started venturing out into the open areas of the Laboratory. As the deer population increased, so did reports of deer eating shrubbery on the developed portions of the Laboratory. By the end of 2000, evidence of severe browsing on ornamental shrubs was documented throughout the site. While not a threat to human health, the damage to shrubbery may result in the need to replace shrubs at substantial cost to BNL. Options for managing the deer population continue to be evaluated, and BNL continues to work with state regulators to determine the best method for controlling the deer population.

#### 6.1.4 COMPLIANCE ASSURANCE AND POTENTIAL IMPACT ASSESSMENT

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

### 6.2 ESTABLISHMENT OF THE UPTON ECOLOGICAL AND RESEARCH RESERVE

On November 9, 2000, Secretary of Energy Bill Richardson, and Susan MacMahon, Acting Regional Director of Region Five U.S. Fish and Wildlife Service (FWS) dedicated 530 acres (214 hectares) of the Laboratory property as an ecological research reserve. The property was designated by DOE as the Upton Ecological and Research Reserve (see Figure 1-7 in Chapter 1) and is to be managed by the U.S. Fish and Wildlife Service under an Interagency Agreement between the Department of Energy and FWS (DOE-FWS 2000). The Upton Reserve, located on the eastern edge of BNL (see Figure 6-4), is home to a wide variety of flora and fauna. It contains wetlands and is partly within the core preservation area of the Long Island Central Pine Barrens. Based on information from the 1994-1995 biological survey of BNL, it is expected that over 200 plant species may be found within the reserve, and more than 162 species of mammals, birds, fish, reptiles and amphibians (LMS 1995). In establishing the Upton Reserve, DOE committed to provide the FWS with $1,000,000 over a five-year period for the management of the reserve. In the first year of its existence, the FWS will hire two biologists, formally establish the boundary and post the area. They will also begin baseline biological survey work, initiate basic research, and conduct educational programs. The supervisory biologist from the FWS will serve as a member of a Technical Advisory Group to be established to assist BNL with the development of a Natural Resource Management Plan. Additional information concerning the establishment of the Upton Reserve may by found on the Internet at <http://www.bnl.gov/esd/reserve.htm>.

#### 6.2.1 TECHNICAL ADVISORY GROUP

The Interagency Agreement establishing the Upton Ecological and Research Reserve also made provisions for the establishment of the Technical Advisory Group to provide technical input in the development of a comprehensive Natural Resource Management Plan for the management of both the Upton Reserve and the remainder of the BNL property. This comprehensive plan will replace the existing Wildlife Management Plan. The Technical Advisory Group will also develop criteria for the solicitation, review, and award of research funds for proposals on research to be conducted within the Upton Reserve. BNL expects participation on the Technical Advisory Group to include representatives from the NYSDEC, Suffolk County Parks Department, Peconic Estuary Program, Central Pine Barrens Joint Policy and Planning Commission, FWS, DOE, Citizens Advisory Council, Brookhaven Executive Roundtable, U.S. National Park Service, Brookhaven Science

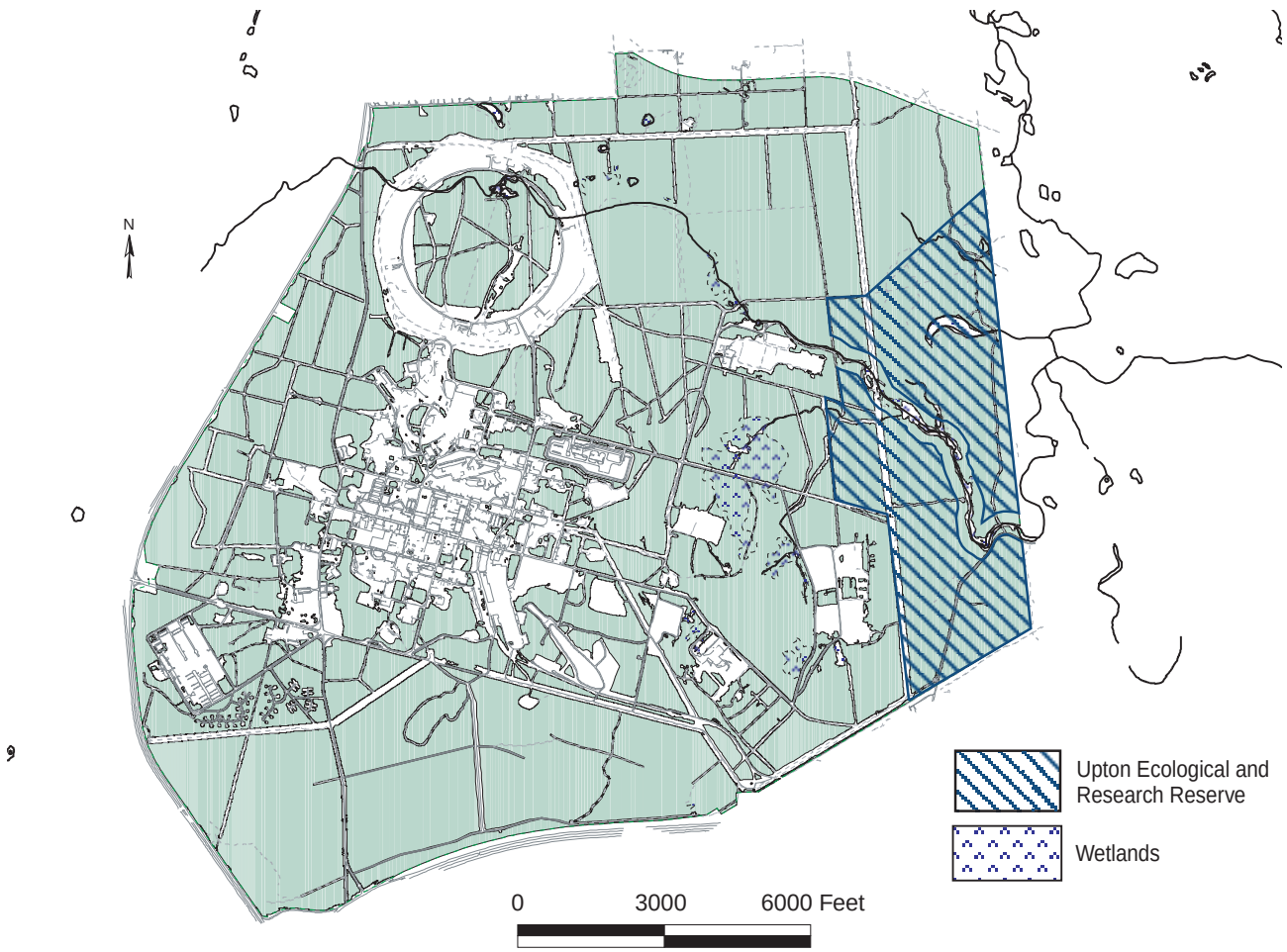


**Figure 6-4. BNL Site Map Indicating the Boundary of the Upton Ecological and Research Reserve.**

Associates, and The Nature Conservancy. Letters to the various agencies and organizations requesting formal participation in the Technical Advisory Group were mailed in December 2000. The formation and first meeting of the Group is planned for early 2001.

### 6.3 FLORA AND FAUNA MONITORING ACTIVITIES

BNL conducts routine monitoring of flora and fauna in order to determine whether past or present activities conducted by the Laboratory have had any impacts on the surrounding environment. Due to the distribution of soils contaminated with cesium-137 in some of the landscaped areas, some contamination is found in deer, and possibly other plants and animals. The sections below describe the results of the annual sampling conducted under the flora and fauna monitoring program.

#### 6.3.1 DEER SAMPLING

Deer in New York State typically grow to large sizes, with average weights of males at approximately 150 pounds; females are one third less at about 100 pounds. However, deer on Long Island tend to be much smaller in size, with an average weight of less than 80 pounds. The available meat on local deer ranges from 20 to 40 pounds per deer.

In 2000, as in recent years, an offsite deer sampling program was again conducted in cooperation with the NYSDEC Wildlife Branch. NYSDEC samples provide data on deer moving beyond BNL boundaries, where they can be legally hunted. This program also provides control data on deer living in locations that are distant from BNL. In addition to samples taken offsite by NYSDEC, samples were obtained from road kill near BNL and

hunter donations were obtained from Laboratory employees. The total number of samples obtained near the BNL site increased from past years due to a large number of deer/vehicle accidents both on and off the site, and the increased donations from hunters. In all, 28 deer samples were obtained onsite and 21 were gathered from offsite locations.

BNL has been monitoring radionuclide levels in deer onsite since 1992. Onsite samples were collected primarily from deer killed in vehicle accidents. Samples were analyzed for gamma-emitting radionuclides; the results are shown in Table 6-3. It has been previously established that deer taken on the BNL site contain concentrations of cesium-137 (half-life = 30 years) at levels above those taken from offsite. This is most likely the result of deer grazing on vegetation growing in soils where elevated cesium-137 levels are known to exist. Cesium-137 in these soils can be transferred to aboveground plant matter via root uptake, where it then becomes available to browsing animals. Removal of contaminated soil areas has occurred under the site Environmental Restoration Program. All major areas of contamination in lawn soils were remediated in 2000. Some soil contamination is still present in areas that are part of Operable Units I/VI and V. The Record of Decision for Operable Units I and Radiologically Contaminated Soils was issued on October 5, 1999 (BNL 1999). The cleanup of areas covered by this Record of Decision is scheduled and will be completed based on availability of funds. A Record of Decision for Operable Unit V has not yet been signed. In 2000, a decision was made to separate the cleanup of the Sewage Treatment Plant (STP) from the Peconic River cleanup.

All data obtained since 1992 were presented in the *1999 Site Environmental Report* (BNL 2000) including the distribution of cesium-137 levels in deer versus distance from the Laboratory was presented. Cesium-137 concentrations decrease sharply beyond one mile (1.6 kilometers) from the BNL boundary. This indicates that deer feeding on Laboratory property have the potential to migrate short distances offsite and also supports the estimates of the deer home range being one square mile.

The maximum onsite concentration of cesium-137 detected in all deer meat samples was 7.31 pCi/g (0.27 Bq/g) wet weight (the concentration prior to drying for analysis). The arithmetic average concentration of all onsite samples of meat in which cesium-137 was detected was 1.48 pCi/g (0.05 Bq/g). This can be compared with the maximum and average cesium-137 concentrations in meat recorded in offsite samples of 7.57 and 2.07 pCi/g (0.28 and 0.08 Bq/g), respectively. Cesium-137 concentrations in offsite deer were separated into two groups: those samples taken within one mile of BNL and samples taken greater than one mile from BNL (see Table 6-3). Cesium-137 concentrations in deer meat samples taken within one mile of BNL range from 0.28 – 7.57 pCi/g (0.01 – 28 Bq/g), while concentrations in deer meat taken from greater than one mile ranged from being nondetectable to 3.60 pCi/g (0 – 0.13 Bq/g). Figure 6-5 compares the ranges of cesium-137 concentrations in meat samples from onsite and offsite deer collected since 1996. The maximum cesium-137 concentration in liver samples collected onsite was 1.21 pCi/g (0.04 Bq/g) and the average was 0.39 pCi/g (0.01 Bq/g). Cesium-137 concentrations in offsite deer liver samples were similar in range as that seen in meat samples in both subpopulations.

Figure 6-6 presents the trends in arithmetic averages of both onsite and offsite cesium-137 concentrations in deer meat samples taken from 1996 through 2000. The downward trend in cesium-137 concentrations in onsite samples could be indicative of two factors: (1) a more accurate estimate based on an increased number of samples taken per year, and (2) a larger number of young deer taken in 2000, which resulted in lower concentrations of cesium-137 accumulating in tissues. The trend in cesium-137 concentrations in offsite samples indicates a leveling off of cesium-137 around 2.00 pCi/g (0.07 Bq/g). The arithmetic average of the 23 samples taken since 1996 from locations greater than one mile from BNL is 0.69 pCi/g (0.03 Bq/g). The onsite average concentration of cesium-137 of 1.48 pCi/g (0.05 Bq/g) is therefore 2.14 times greater than the average offsite concentration from deer located more than one mile from the Laboratory.

The potential radiological dose resulting from deer meat consumption is discussed in Chapter 8. The New York State Department of Health has formally assessed the potential public health risk associated with the elevated cesium-137 levels in onsite deer and deter-

**Table 6-3. Radiological Analysis Results of Deer Tissue (CY 2000).**

| Sampling Location | Collection Date | Tissue | K-40 (pCi/g, wet weight) | Cs-137 (pCi/g, wet weight) | Sr-90 (pCi/g, wet weight) |
|---|---|---|---|---|---|
| **BNL** | | | | | |
| AGS area | 01/08/00 | Flesh | 3.13 ± 0.90 | 1.81 ± 0.35 | |
| | | Liver | 1.80 ± 0.45 | 0.39 ± 0.08 | |
| Princeton Ave. | 04/19/00 | Flesh | 1.92 ± 0.34 | 0.37 ± 0.06 | |
| | | Liver | 2.09 ± 0.37 | 0.16 ± 0.03 | |
| Princeton Ave. | 04/25/00 | Flesh | 4.15 ± 1.11 | 1.70 ± 0.36 | |
| | | Liver | 2.97 ± 0.75 | 0.24 ± 0.06 | |
| Near main gate | 05/02/00 | Flesh | 2.25 ± 0.38 | 0.52 ± 0.09 | |
| RHIC near 12 o'clock outside of ring | 05/18/00 | Flesh | 2.75 ± 0.50 | 0.84 ± 0.15 | |
| | | Flesh* | 2.89 ± 0.49 | 0.97 ± 0.17 | |
| RHIC Bldg. 1005 | 05/24/00 | Flesh | 2.42 ± 0.40 | 1.07 ± 0.18 | |
| | | Liver | 2.41 ± 0.42 | 0.44 ± 0.08 | |
| RHIC near 2 o'clock outside of ring | 05/31/00 | Flesh | 4.35 ± 1.01 | 1.88 ± 0.39 | |
| | | Liver | 2.80 ± 1.06 | 0.34 ± 0.11 | |
| RHIC near 2 o'clock outside of ring | 06/01/00 | Flesh | 2.67 ± 0.46 | 1.17 ± 0.20 | |
| RHIC near 6 o'clock | 06/20/00 | Flesh | 2.41 ± 0.42 | 0.29 ± 0.05 | |
| | | Flesh* | 2.85 ± 0.48 | 0.37 ± 0.06 | |
| RHIC near 6 o'clock | 06/20/00 | Liver | 2.37 ± 0.42 | 0.13 ± 0.03 | |
| Near Bldg. 535 | 06/27/00 | Flesh | 2.88 ± 0.48 | 0.21 ± 0.04 | |
| | | Liver | 2.09 ± 0.36 | 0.06 ± 0.01 | |
| Railroad & East Fifth Ave. | 06/29/00 | Flesh | 2.75 ± 0.46 | 0.53 ± 0.09 | |
| SE corner, 7th & Brookhaven Ave. | 08/11/00 | Flesh | 2.69 ± 0.44 | 0.07 ± 0.02 | |
| | | Flesh* | 2.40 ± 0.45 | 0.03 ± 0.01 | |
| | | Bone | | | 1.08 ± 0.16 |
| West of main gate Princeton Ave. | 09/18/00 | Flesh | 2.64 ± 0.44 | 1.78 ± 0.30 | |
| | | Liver | 3.18 ± 0.83 | 0.41 ± 0.12 | |
| | | Bone | | | 3.00 ± 0.24 |
| AGS Ring | 10/25/00 | Flesh | 2.30 ± 0.39 | 0.61 ± 0.10 | |
| | | Liver | 3.37 ± 1.01 | 0.27 ± 0.12 | |
| | | Bone | | | 0.69 ± 0.08 |
| Bldg. 933 | 10/25/00 | Flesh | 3.90 ± 0.85 | 0.32 ± 0.08 | |
| | | Liver | 4.45 ± 1.20 | 0.14 ± 0.06 | |
| | | Bone | | | 1.36 ± 0.19 |
| North side of Princeton Ave. | 10/31/00 | Flesh | 2.52 ± 0.45 | 1.64 ± 0.28 | |
| at motor vehicle garage | | Liver | 2.44 ± 0.43 | 1.21 ± 0.21 | |
| | | Bone | | | 1.29 ± 0.13 |
| Brookhaven Ave. north side | 10/31/00 | Flesh | 6.98 ± 1.54 | 7.31 ± 1.45 | |
| | | Liver | 1.44 ± 0.34 | 0.95 ± 0.21 | |
| | | Bone | | | 1.57 ± 0.14 |
| Princeton Ave. 200 ft. east of main gate | 11/03/00 | Flesh | 2.02 ± 0.37 | 1.44 ± 0.25 | |
| | | Bone | | | 1.72 ± 0.18 |
| Peconic River Rd. | 11/07/00 | Flesh | 3.01 ± 0.50 | 4.87 ± 0.81 | |
| | | Bone | | | 4.34 ± 0.31 |
| Brookhaven Ave. near Hazardous Waste Facility | 11/15/00 | Flesh | 5.85 ± 1.23 | 3.86 ± 0.77 | |
| | | Liver | 2.58 ± 0.94 | 0.73 ± 0.19 | |
| | | Bone | | | 1.65 ± 0.15 |

*(continued on next page)*

**Table 6-3. Radiological Analysis Results of Deer Tissue (CY 2000)** *(continued)*.

| Sampling Location | Collection Date | Tissue | K-40 (pCi/g, wet weight) | Cs-137 (pCi/g, wet weight) | Sr-90 (pCi/g, wet weight) |
|---|---|---|---|---|---|
| Railroad St. south of Brookhaven Ave. | 11/15/00 | Flesh | 2.59 ± 0.43 | 0.67 ± 0.12 | |
| | | Bone | | | 1.11 ± 0.12 |
| Pinceton Ave. 200' west of main gate | 11/18/00 | Flesh | 2.64 ± 0.45 | 4.72 ± 0.80 | |
| | | Bone | | | 3.98 ± 0.52 |
| Princeton Ave. west bound lane at main gate | 12/04/00 | Flesh | 2.51 ± 0.44 | 0.87 ± 0.15 | |
| | | Flesh* | 3.16 ± 0.75 | 1.20 ± 0.23 | |
| | | Liver | 3.18 ± 0.91 | 0.32 ± 0.11 | |
| | | Bone | | | 3.58 ± 0.51 |
| Princeton Ave. west bound, north of motor vehicle garage | 12/27/00 | Flesh | 2.38 ± 0.42 | 0.43 ± 0.07 | |
| | | Liver | 2.23 ± 0.50 | 0.12 ± 0.03 | |
| | | Bone | | | 1.34 ± 0.31 |
| **Offsite < 1 mile** | | | | | |
| Wm. Floyd Pkwy, 1/2 mile north of main gate | 01/11/00 | Flesh | 2.38 ± 0.44 | 0.77 ± 0.13 | |
| | | Flesh* | 4.18 ± 1.09 | 1.76 ± 0.37 | |
| | | Liver | 1.86 ± 0.33 | 0.25 ± 0.04 | |
| Wm. Floyd Pkwy, 1/4 mile north of main gate | 04/27/00 | Flesh | 2.05 ± 0.37 | 0.35 ± 0.06 | |
| Wm. Floyd Pkwy, 1/4 mile south of main gate | 07/13/00 | Flesh | 1.98 ± 0.35 | 0.28 ± 0.05 | |
| | | Liver | 2.60 ± 0.45 | 0.15 ± 0.03 | |
| South Gate ramp to Wm. Floyd Pkwy | 09/22/00 | Flesh | 3.39 ± 0.72 | 2.21 ± 0.39 | |
| | | Liver | 1.93 ± 0.43 | 0.62 ± 0.14 | |
| | | Bone | | | 2.22 ± 0.23 |
| South gate LIE Service Rd | 10/02/00 | Flesh | 2.96 ± 0.49 | 0.68 ± 0.12 | |
| | | Liver | 2.53 ± 0.67 | 0.26 ± 0.07 | |
| | | Bone | | | 1.87 ± 0.19 |
| Wm. Floyd Pkwy, east side main gate | 10/31/00 | Flesh | 2.69 ± 0.46 | 7.57 ± 1.28 | |
| | | Liver | 2.35 ± 0.46 | 5.46 ± 0.94 | |
| | | Bone | | | 3.03 ± 0.27 |
| Wm. Floyd Pkwy. | 11/03/00 | Flesh | 2.35 ± 0.41 | 4.99 ± 0.84 | |
| | | Bone | | | 4.61 ± 0.54 |
| Wm. Floyd Pkwy. | 11/08/00 | Flesh | 2.15 ± 0.39 | 7.41 ± 1.26 | |
| | | Heart | 2.46 ± 0.79 | 5.50 ± 0.97 | |
| | | Bone | | | 4.30 ± 0.49 |
| Wm. Floyd Pkwy. | 11/12/00 | Flesh | 2.67 ± 0.45 | 2.50 ± 0.42 | |
| | | Liver | 4.50 ± 2.23 | 2.56 ± 0.60 | |
| | | Bone | | | 3.47 ± 0.51 |
| Wm. Floyd Pkwy. north bound, south of main gate | 12/05/00 | Flesh | 2.22 ± 0.38 | 2.06 ± 0.35 | |
| | | Flesh* | 2.37 ± 0.42 | 1.94 ± 0.33 | |
| | | Liver | 2.08 ± 0.37 | 0.85 ± 0.15 | |
| | | Bone | | | 1.40 ± 0.37 |
| **Offsite > 1 mile** | | | | | |
| Railroad Ave., Center Moriches | 05/20/00 | Flesh | 2.25 ± 0.39 | 0.14 ± 0.03 | |
| | | Flesh* | 2.06 ± 0.37 | 0.13 ± 0.03 | |
| | | Bone | | | 5.88 ± 0.59 |
| River Rd., Calverton (east of Grumman) | 09/08/00 | Flesh | 1.66 ± 0.28 | 3.47 ± 0.59 | |
| | | Bone | | | 4.60 ± 0.55 |

*(continued on next page)*

**Table 6-3. Radiological Analysis Results of Deer Tissue (CY 2000)** *(concluded)*.

| Sampling Location | Collection Date | Tissue | K-40 (pCi/g, wet weight) | Cs-137 (pCi/g, wet weight) | Sr-90 (pCi/g, wet weight) |
|---|---|---|---|---|---|
| Kingsfield, ME | 11/18/00 | Flesh | 5.83 ± 1.05 | 3.60 ± 0.62 | |
| | | Flesh* | 2.52 ± 0.45 | 1.36 ± 0.23 | |
| Margaretsville, NY | 11/22/00 | Heart | 1.92 ± 0.34 | 0.14 ± 0.03 | |
| | | Liver | 3.49 ± 0.85 | 0.15 ± 0.07 | |
| | | Bone | | | 1.79 ± 0.40 |
| Cooksburg, NY | 11/25/00 | Flesh | 1.73 ± 0.31 | ND | |
| | | Liver | 4.28 ± 1.13 | ND | |
| | | Bone | | | 3.92 ± 0.53 |
| Cooksburg, NY | 11/25/00 | Flesh | 3.05 ± 0.76 | 0.08 ± 0.03 | |
| | | Liver | 2.34 ± 0.40 | ND | |
| | | Bone | | | 0.90 ± 0.29 |
| Potter Hollow, NY | 12/08/00 | Flesh | 1.55 ± 0.26 | 0.01 ± 0.00 | |
| | | Liver | 4.89 ± 0.95 | ND | |
| | | Bone | | | 1.44 ± 0.40 |
| Potter Hollow, NY | 12/08/00 | Flesh | 1.87 ± 0.31 | 0.01 ± 0.00 | |
| | | Liver | 1.75 ± 0.30 | ND | |
| | | Bone | | | 1.46 ± 0.39 |
| **Averages by Tissue** | | | | | |
| **Flesh** | | | | | |
| Average for all samples | 49 samples | | 2.83 ± 0.55 | 1.73 ± 0.31 | |
| BNL Onsite Avg. | 28 samples | | 3.04 ± 0.59 | 1.48 ± 0.27 | |
| BNL Onsite & Offsite < 1 mile Avg. | 40 samples | | 2.91 ± 0.56 | 1.85 ± 0.33 | |
| Offsite Avg. | 21 samples | | 2.57 ± 0.48 | 2.07 ± 0.36 | |
| Offsite Avg. < 1 mile | 12 samples | | 2.62 ± 0.50 | 2.71 ± 0.47 | |
| Offsite Avg. >1 mile | 9 samples | | 2.50 ± 0.47 | 1.10 ± 0.19 | |
| **Liver** | | | | | |
| Average for all samples | 27 samples | | 2.74 ± 0.69 | 0.71 ± 0.15 | |
| BNL Onsite Avg. | 15 samples | | 2.63 ± 0.66 | 0.39 ± 0.10 | |
| BNL Onsite & Offsite < 1 mile Avg. | 22 samples | | 2.60 ± 0.68 | 0.73 ± 0.16 | |
| Offsite Avg. | 12 samples | | 2.88 ± 0.71 | 1.29 ± 0.25 | |
| Offsite Avg. < 1 mile | 7 samples | | 2.55 ± 0.71 | 1.45 ± 0.28 | |
| Offsite Avg. >1 mile | 5 samples | | 3.35 ± 0.73 | 0.15 ± 0.07 | |
| **Bone** | | | | | |
| Average for all samples | 27 samples | | | | 2.50 ± 0.33 |
| BNL Onsite Avg. | 13 samples | | | | 2.05 ± 0.23 |
| BNL Onsite & Offsite < 1 mile Avg. | 20 samples | | | | 2.38 ± 0.28 |
| Offsite Avg. | 14 samples | | | | 2.92 ± 0.41 |
| Offsite Avg. < 1 mile | 7 samples | | | | 2.99 ± 0.37 |
| Offsite Avg. >1 mile | 7 samples | | | | 2.86 ± 0.45 |

Notes:
All values shown with a 95% confidence interval.
ND = Not Detected
*Duplicate sample or analysis

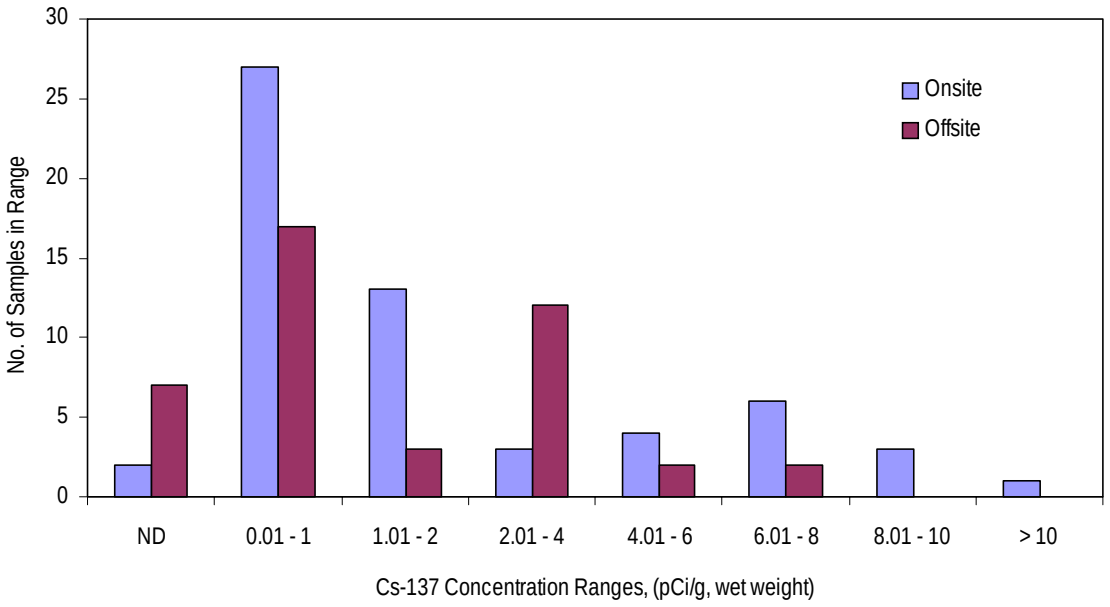


**Figure 6-5. Ranges of Cesium-137 Concentrations in Deer Samples Collected Onsite and Offsite (1996-2000).**

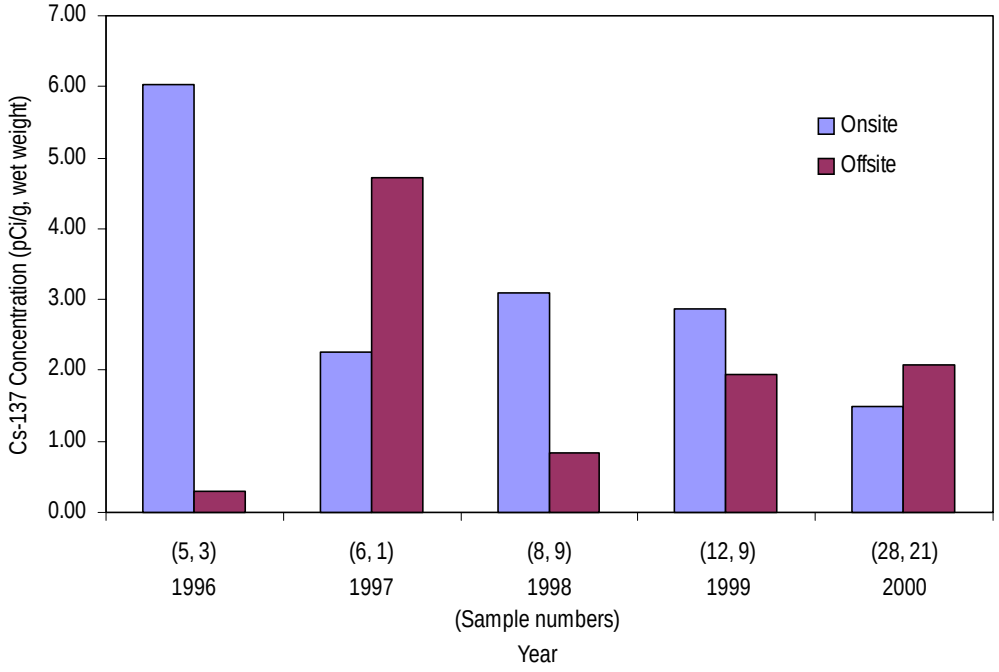


**Figure 6-6. Cesium-137 Average Concentrations in Meat Taken From Onsite and Offsite Deer (1996-2000).**

mined that neither hunting restrictions nor formal health advisories are warranted (NYSDOH 1999). Their report may be accessed at <http://www.bnl.gov/wildlife/deer_issues.htm/>.

With respect to the health of the onsite deer population, the International Atomic Energy Agency (IAEA) has concluded that chronic dose rates of 100 millirad per day (1 mGy/d), to even the most radiosensitive species in terrestrial ecosystems, are unlikely to cause detrimental effects in animal populations (IAEA 1992). A deer containing a uniform distribution of cesium-137 at the highest levels observed to

date would carry a total body burden of about 0.2 μCi (0.007 MBq). Under these conditions, an animal would receive an absorbed dose of approximately 3 millirad per day (0.03 mGy/d), which is only 3% of the threshold evaluated by the IAEA. Deer observed and sampled onsite appear to be healthy.

BNL began testing bone (when available) for strontium-90 content during 2000. Strontium-90 ranged from 0.69 to 4.34 pCi/g (0.03 – 0.16 Bq/g) in onsite samples, 1.40 to 4.61 pCi/g (0.05 – 0.17 Bq/g) in samples taken within one mile of BNL, and 0.90 to 5.88 pCi/g (0.03 – 0.22 Bq/g) in samples taken from locations greater than a mile from BNL. This overlap in values between all samples suggests that strontium-90 is present in the environment at background levels and is likely a result of worldwide fallout from nuclear weapons testing. Strontium-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 strontium-90 in bone to build baseline information on this radionuclide and its presence in deer.

#### 6.3.2 SMALL MAMMAL SAMPLING

BNL instituted small mammal sampling in 2000 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 items compared to deer. Offsite samples were obtained from a licensed trapper located west of the William Floyd Parkway, while onsite samples came from various locations around BNL. Squirrels were sent to an offsite lab for dissection and analysis. The meat was separated from the bone and tested for gamma-emitting radionuclides, while the bone was tested for strontium-90. Results of the testing are presented in Table 6-4. Cesium-137 in offsite samples ranged from less than the minimum detection level to 0.72 pCi/g (0.03 Bq/g). Onsite samples contained cesium-137 ranging from 0.27 to 12.40 pCi/g (0.01 – 0.46 Bq/g). Strontium-90 at 1.45 pCi/g (0.05 Bq/g) was found in the bone of a single opossum taken near Building 533. The cesium levels in two squirrels were high, 10.90 and 12.40 pCi/g (0.40 and 0.46 Bq/g), compared to all other samples including deer (see Table 6-3). The source of the contamination is unknown at this time for the squirrel taken at the current landfill (closed). The squirrel taken near the Sewage Treatment Plant is likely to have acquired cesium-137 from eating vegetation growing in the contaminated soils there. Small mammals will continue to be sampled to obtain added information about their usefulness in environmental surveillance and to better define where they may be acquiring cesium-137 from the environment.

#### 6.3.3 GOOSE FECAL MATERIAL

The Laboratory has a resident population of Canada geese (*Branta Canadensis*) that fluctuates between 80 and 120 birds. Canada geese are tend to feed on green grasses and weedy plants, and may ingest soil as they pull young plants out of the ground. In 2000, BNL initiated the sampling of goose fecal material along with sampling of lawn grasses to determine if there was potential for the Canada goose population to pick up cesium-137 contamination that has been historically present in some of the landscape soils. Table 6-5 displays the data from the radiological analysis of the goose fecal material as well as grass taken in the area where the fecal material was obtained. A sample of grass clippings from the Weaver Drive pond area was the only one that showed any level of cesium-137 present. However, goose fecal material showed low levels of cesium-137 ranging from 0.07 pCi/g to 0.64 pCi/g (0.003 Bq/g to 0.02 Bq/g) in various locations onsite at BNL. This suggests that geese feeding on the lawns at BNL have at least the potential to concentrate cesium-137 in their digestive tract. At present there are no data about cesium-137 in the geese. BNL will continue to look at cesium-137 levels in fecal material and compare it to levels found in lawn vegetation. If sampling of geese were warranted, then the Laboratory would acquire the necessary licenses before obtaining samples.

#### 6.3.4 FISH SAMPLING

BNL, in collaboration with the NYSDEC Fisheries Division, maintains an ongoing program for the collection and analysis of fish from the Peconic River and surrounding fresh water bodies. In 2000, various species of fish were collected from onsite portions of the Peconic River, as well as from offsite locations such as Swan Pond, Donahue's Pond, and

**Table 6-4. Radiological Analysis of Small Mammals (CY 2000).**

| Location | Species | K-40 (pCi/g, wet weight) | Cs-137 (pCi/g, wet weight) | Sr-90 (pCi/g, wet weight) |
|---|---|---|---|---|
| **BNL** | | | | |
| BNL | Woodchuck | 21.60 ± 4.00 | 0.40 ± 0.24 | ND |
| BNL - Current Landfill | Squirrel | 8.93 ± 1.05 | 10.90 ± 1.53 | ND |
| BNL- Bldg. 533 | Opossum | 7.08 ± 1.13 | 0.56 ± 0.09 | 1.45 ± 0.51 |
| BNL | Squirrel | 7.82 ± 0.82 | 12.40 ± 0.21 | ND |
| BNL- Ball fields | Squirrel | 10.40 ± 1.23 | 0.80 ± 0.09 | ND |
| BNL- Bldg. 533 | Squirrel | 10.50 ± 1.18 | 1.62 ± 0.11 | ND |
| BNL- Bldg. 475 | Squirrel | 12.10 ± 0.72 | 0.78 ± 0.03 | ND |
| BNL- Bldg. 533 | Squirrel | 8.69 ± 1.04 | 0.56 ± 0.07 | ND |
| BNL- Bldg. 533 | Squirrel | 7.94 ± 1.03 | 0.27 ± 0.06 | ND |
| BNL- Bldg. 533 | Squirrel | 7.30 ± 0.98 | 0.58 ± 0.06 | ND |
| **Offsite** | | | | |
| William Floyd Highway | Squirrel | 5.47 ± 0.76 | 0.72 ± 0.06 | ND |
| William Floyd Highway | Squirrel | 8.17 ± 0.89 | <MDL | ND |
| William Floyd Highway | Squirrel | 11.50 ± 1.49 | <MDL | ND |
| William Floyd Highway | Squirrel | 6.39 ± 0.85 | 0.63 ± 0.08 | ND |
| William Floyd Highway | Squirrel | 4.71 ± 0.65 | 0.58 ± 0.06 | ND |

Notes:
All values shown with a 95% confidence interval.
ND = Not Detected
MDL = Minimum Detection Limit

**Table 6-5. Radiological Analysis of Goose Fecal Material and Associated Grass Clippings (CY 2000).**

| Location | Material | K-40 (pCi/g, wet weight) | Cs-137 (pCi/g, wet weight) |
|---|---|---|---|
| **BNL** | | | |
| Weaver Drive | Goose droppings | 19.14 ± 5.94 | ND |
| | Goose droppings* | 4.70 ± 2.95 | ND |
| | Grass | 2.39 ± 0.61 | 0.05 ± 0.02 |
| Bldg. 464 | Goose droppings | 7.89 ± 1.69 | 0.37 ± 0.10 |
| | Grass | 16.60 ± 4.66 | ND |
| Bldg. 490 | Goose droppings | 5.37 ± 1.03 | 0.07 ± 0.03 |
| | Grass | 4.93 ± 1.14 | ND |
| West Ballfield | Goose droppings | 6.02 ± 4.65 | ND |
| | Grass | 20.26 ± 8.34 | ND |
| Rutherford and Lawrence | Goose droppings | 0.79 ± 0.25 | 0.64 ± 0.29 |
| | Grass | 3.94 ± 0.90 | ND |
| **Offsite** | | | |
| Spring Lake, Middle Island | Goose droppings | 4.75 ± 1.11 | ND |
| | Grass | 3.92 ± 0.72 | ND |

Notes:
All values shown with a 95% confidence interval.
ND = Not Detected
*Duplicate sample

Forge Pond (see Figure 6-7 for geographic locations). Control location samples were taken from Lower Lake on the Carmans River. Sampling onsite and on the Carmans River is carried out through a contract with Cold Springs Harbor Fish Hatchery and Museum. The annual sampling onsite over the past several years has resulted in the requirement to take more fish of a smaller size to obtain a sample sufficiently large to complete all analyses desired. Because the fish population onsite is not maturing, BNL intends to suspend onsite sampling, beginning in 2001, for up to three years to allow the onsite fish populations to recover and mature. Annual population and size estimates will be conducted to track the recovery. Offsite sampling will continue as in the past. All samples were analyzed for whole body content of each of the analytes reported; and in most instances, the samples were a composite of several fish to ensure adequate sample size for analysis.

#### 6.3.4.1 RADIOLOGICAL ANALYSIS OF FISH

Brown bullhead (*Ictalurus nebulosus*), chain pickerel (*Esox niger*), largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), pumpkinseed *(Lepomis gibbosus*), creek chubsucker (*Erimyzon oblongus*), and golden shiner (*Notemigonus crysoleucas)* species were collected in 2000 by BNL and NYSDEC for radiological analysis. Gamma spectroscopy analysis was performed on all samples. Specific information regarding the sampling point, species collected, and analytical results is presented in Table 6-6. All sample results are presented as wet weight concentrations.

Cesium-137 was identified in onsite samples at levels ranging from 0.86 pCi/g (0.03 Bq/g) in creek chubsuckers, to 1.30 pCi/g (0.05 Bq/g) in a brown bullhead. The highest level of cesium-137 found in offsite fish was 0.66 pCi/g (0.02 Bq/g) in a largemouth bass from Donahue's Pond. Cesium-137 was not detected in any of the fish taken from the Carmans River.

In 2000, BNL initiated testing for Strontium-90. Strontium-90 is readily deposited in bone. Stronium-90 was not detected in any of the onsite fish but was found at the highest detected level of 1.82 pCi/g (0.07 Bq/g) in largemouth bass taken from Donahue's Pond. Since this is the first year of testing for strontium-90, no substantial conclusions can be made from these data. Because fish were analyzed for whole body content, values for strontium-90 may vary widely as seen in the data presented here. These variations result from random pieces of bone included in the aliquot of the sample used for the analysis. The lack of detected levels in BNL onsite samples may also be due to the small size of the fish used to generate a composite sample. Younger fish would have less bone mass than older fish. BNL will continue to test for strontium-90 in offsite samples in order to build baseline values for future comparisons.

Concentrations of naturally occurring potassium-40 (a radionuclide common to soil and vegetation) were observed to be very consistent between the Peconic River and control location fish,

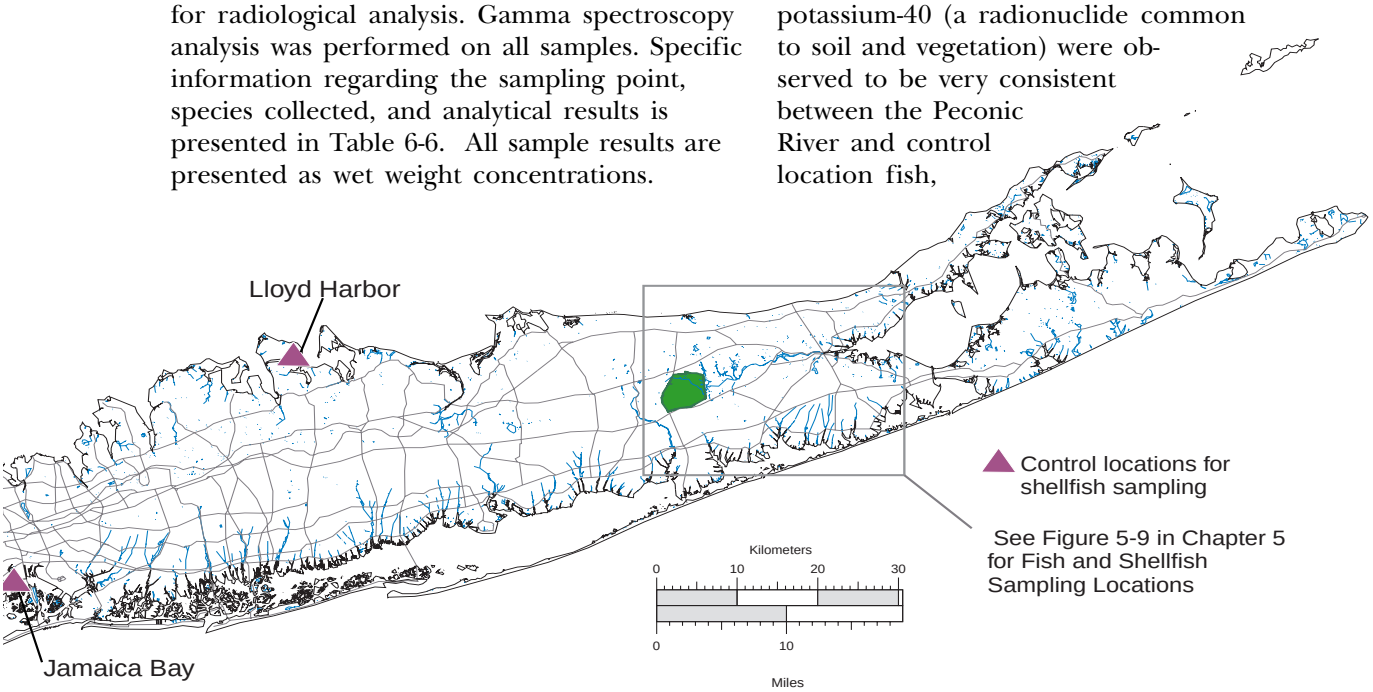


**Figure 6-7. Area of Sampling Locations for Fish and Shellfish Taken in CY 2000.**

**Table 6-6. Radiological Analysis of Fish from the Peconic River System and Control Locations (CY 2000).**

| Fish/Sample Type | K-40 (pCi/g, wet weight) | Cs-137 (pCi/g, wet weight) | Sr-90 (pCi/g, wet weight) |
|---|---|---|---|
| **BNL HM-EA** | | | |
| Brown bullhead/composite | 9.97 ± 1.25 | 1.30 ± 0.16 | <MDL |
| Pumpkinseed/composite | 7.81 ± 1.04 | 1.19 ± 0.14 | <MDL |
| Chain Pickerel/composite | 10.51 ± 1.24 | 1.13 ± 0.17 | ND |
| Chubsucker/composite | 9.87 ± 2.48 | 0.86 ± 0.24 | <MDL |
| **Swan Pond** | | | |
| Pumkinseed/composite | 8.90 ± 1.14 | <MDL | 0.79 ± 0.15 |
| Brown Bullhead/whole body | 11.40 ± 1.57 | 0.51 ± 0.05 | 1.30 ± 0.10 |
| Largemouth Bass/composite | 7.98 ± 1.26 | 0.44 ± 0.10 | <MDL |
| **Donahue's Pond** | | | |
| Brown bullhead/composite | 10.10 ± 1.42 | 0.50 ± 0.09 | 1.37 ± 0.12 |
| Largemouth Bass/composite | 9.19 ± 1.33 | 0.66 ± 0.10 | 1.82 ± 0.17 |
| Pumpkinseed/composite | 6.94 ± 1.21 | 0.34 ± 0.08 | 1.39 ± 0.13 |
| **Forge Pond** | | | |
| Brown Bullhead/composite | 9.64 ± 1.42 | 0.29 ± 0.07 | <MDL |
| Largemouth Bass/composite | 8.58 ± 1.23 | 0.45 ± 0.08 | 0.60 ± 0.08 |
| **Lower Lake, Carmans River** | | | |
| Golden Shiners/composite | 8.08 ± 1.38 | ND | ND |
| Bluegill/composite | 8.05 ± 1.13 | <MDL | ND |
| Bass/composite | 8.97 ± 1.28 | <MDL | ND |
| Pumpkinseed/composite | 8.36 ± 1.20 | <MDL | <MDL |
| Brown bullhead/composite | 9.50 ± 1.53 | ND | <MDL |

Notes:
See Figure 6-7 for sampling locations.
All values shown with a 95% confidence interval.
MDL = Minimum Detection Limit
ND = Not Detected

validating the comparability of the data. The only anthropogenic (human-made) radionuclide found in any fish sample, control or otherwise, was cesium-137.

Some cesium-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 control location (Swan Pond and Carmans River) fish from past and present years. In the past, cesium-137 values up to 0.43 pCi/g (0.02 Bq/g) were found in yellow perch (*Perca flavescens*) flesh taken from Swan Pond. Current levels are no higher than 0.51 pCi/g (0.02 Bq/g) in brown bullheads, while fish from the Carmans River show either less than minimum detection limits or none at all. In order to account for the different feeding habits and weights of various species, it is important to compare species with similar feeding habits. In general, cesium-137 concentrations in bullheads collected near the BNL Sewage Treatment Plant outfall were elevated in comparison to the control locations. The elevations became less pronounced with increasing distance from the Sewage Treatment Plant outfall (see the Donahue's Pond and Forge Pond values in Table 6-6). Cesium-137 values in fish from both Donahue's Pond and Forge Pond are roughly equivalent to those seen at Swan Pond.

Though it is clear from discharge records and sediment sampling that historical BNL operations have contributed to anthropogenic 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.

#### 6.3.4.2 NONRADIOLOGICAL ANALYSIS OF FISH AND SHELLFISH

In 1997, under the Operable Unit V remediation project, the BNL Environmental Restoration Program conducted sampling and analysis of fish samples from the Peconic River for metals, pesticides, and polycholorinated biphenyls (PCBs). Results indicated that the levels found were not considered to have a health impact on fish or humans. However, DOE directed that the sampling of fish for pesticides, metals, and PCBs should be incorporated into the annual environmental sampling program. This analysis was conducted in 1999 and again in 2000. 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 the April-May period, in 1999 sampling was performed during the September-December, and in 2000 sampling occurred in the July-August period. This along with wide variations in fish size, and the need for composite as well as whole body samples to obtain significant mass for analysis, makes the comparison more tenuous as seasonal variations in feeding, energy consumption, and incorporation of nutrients in tissues by fish can be significant.

Table 6-7 shows the concentration levels of metals in fish and shellfish (clams and mussels) for 2000. None of the metal concentrations were considered to be capable of impacting the health of the consumers of such fish or clams, with the exception of mercury. In comparing the metals results from 1997 to 2000 for those species that were analyzed during all periods, it was found that mercury levels in the 2000 onsite samples were higher than those found in 1997. Mercury was found in chain pickerel at 3.72 mg/kg and in brown bullhead catfish at 3.01 mg/kg. Both samples were whole body composites composed of several small fish. The level of mercury in these two samples is above the consumption standard of 1.0 mg/kg set by the U.S. Food and Drug Administration. This could be the result of seasonal difference in the sampling (spring vs. summer), significant differences in the size of fish caught during the different seasons, and/or whole body composites versus tissue sampling (fillet and skin viscera sampling). Although the level of mercury in these fish is high, the likelihood of these fish being eaten is very low. There is no fishing allowed onsite at BNL and the samples were composites made up of fish that are below legal limits for retaining.

Table 6-8 shows the concentration levels of detected pesticides in fish for 2000. The levels do not exceed any standards that constitute health impacts on the consumers of such fish and, therefore, are not considered harmful. No pesticides were detected in onsite samples. The pesticides DDD and DDE were detected at low levels at several offsite locations. These pesticides are breakdown products of DDT which was commonly used before 1970. Chlordane and Dieldrin were also commonly used pesticides and show up at offsite locations in low levels.

Table 6-9 presents the concentration levels of PCBs in fish for 2000. No PCBs were found in offsite fish. However, the PCBs Aroclor 1254 and Aroclor 1260 were found in all onsite samples. Historically, these two compounds were commonly used in electrical equipment onsite at BNL. Present levels are similar to or higher than those seen in 1999. With small numbers of samples for comparison, it is difficult to assess what would be considered an average value. The variation in results may be due to differences in laboratory procedures, sample types (whole body, composites, or tissues), fish sizes, or they may be a true reflection of PCBs present in the fish. However, at the observed levels, these concentrations should not pose a health hazards as fishing is not permitted onsite and all onsite samples were whole body composites made up of fish too small to be legally retained for consumption.

### 6.3.5 MARINE/ESTUARINE SAMPLING

Annual sampling for clams, sediment, and seawater in the Peconic Bay, Flanders Bay, Indian Point, Jamaica Bay, and Lloyd Harbor (control location) was conducted in 2000 (see Figure 6-7). Stakeholder concern that BNL's discharges have affected the clamming industry were the basis for continuing this sampling program. The NYSDEC Marine Fisheries Branch has continued to assist BNL in coordinating the sampling with local baymen. Table 6-10 summarizes the radiological data. The naturally occurring radionuclide potassium-40 continues to be the only radionuclide observed in these samples. In 2000, estuarine vegetation located at Indian Point was once

**Table 6-7. Metals Analysis of Fish and Shellfish From the Peconic River System and Control Locations (CY 2000).**

| Location | Matrix | As | Ba | Cd | Cr | Cu | Fe | Pb | Mn | Hg | Ni | Se | Ag | Na | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ppm (mg/kg, wet weight) | | | | | | | | | | | | | |
| **BNL HM-EA** | Brown Bullhead | ND | <MDL | <MDL | <MDL | 7.16 | 103.00 | <MDL | <MDL | 3.01 | ND | <MDL | ND | 3770 | <MDL |
| | Pumpkinseed | ND | 11.20 | ND | ND | 4.56 | 32.60 | <MDL | 4.14 | 1.28 | ND | 2.46 | ND | 4310 | <MDL |
| | Chain Pickerel | ND | 17.30 | <MDL | ND | 5.83 | 71.30 | <MDL | 11.90 | 3.72 | ND | 3.89 | ND | 4730 | <MDL |
| | Chubsucker | ND | 23.60 | ND | ND | 7.66 | 62.20 | <MDL | 10.90 | 0.96 | 0.53 | 3.72 | ND | 4270 | <MDL |
| **Peconic Bay** | Clams | 2.61 | <MDL | 0.51 | <MDL | 3.19 | <MDL | <MDL | 14.90 | ND | <MDL | <MDL | <MDL | 5340 | 13.00 |
| **Flanders Bay** | Clams | 2.21 | <MDL | <MDL | ND | 1.05 | <MDL | ND | 2.12 | ND | 0.57 | 0.44 | ND | 3460 | 6.44 |
| **Indian Point** | Mussels | 1.72 | <MDL | <MDL | <MDL | 1.81 | <MDL | <MDL | 13.30 | NT | <MDL | 0.70 | <MDL | 4040 | 9.15 |
| **Forge Pond** | Mussels | 0.52 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | ND | 0.54 | ND | 291 | <MDL |
| **Lloyd Harbor** | Clams | 1.08 | <MDL | <MDL | <MDL | 2.89 | <MDL | 0.51 | 12.90 | ND | 0.61 | <MDL | <MDL | 3990 | 14.10 |
| **Jamaica Bay** | Clams | 1.97 | <MDL | <MDL | <MDL | 2.29 | <MDL | <MDL | <MDL | ND | 0.58 | 0.48 | 1.04 | 2830 | <MDL |
| **Forge Pond** | Brown Bullhead | 0.56 | <MDL | ND | <MDL | 2.26 | <MDL | ND | <MDL | NT | ND | 0.85 | <MDL | 1250 | <MDL |
| | Pumpkinseed | <MDL | <MDL | ND | <MDL | 1.30 | <MDL | <MDL | <MDL | NT | ND | 0.89 | ND | 1110 | <MDL |
| | Largemouth Bass | 0.63 | <MDL | ND | <MDL | <MDL | <MDL | ND | <MDL | NT | ND | 1.00 | ND | 815 | <MDL |
| **Swan Pond** | Pumpkinseed | <MDL | 3.33 | ND | 0.44 | <MDL | <MDL | <MDL | 24.50 | <MDL | ND | 0.85 | ND | 1320 | 30.80 |
| | Brown Bullhead | <MDL | 0.97 | ND | ND | 1.20 | <MDL | ND | 9.39 | <MDL | ND | 0.51 | ND | 822 | 6.48 |
| | Bass | ND | <MDL | ND | <MDL | ND | <MDL | ND | 2.49 | <MDL | ND | 0.54 | ND | 1510 | 10.40 |
| **Donahue's Pond** | Brown Bullhead | ND | <MDL | ND | <MDL | 0.59 | <MDL | <MDL | <MDL | <MDL | ND | 0.65 | ND | 910 | <MDL |
| | Largemouth Bass | ND | <MDL | ND | <MDL | ND | <MDL | 0.58 | <MDL | <MDL | ND | 0.65 | ND | 1140 | <MDL |
| | Pumpkinseed | <MDL | <MDL | ND | 0.47 | <MDL | <MDL | <MDL | <MDL | <MDL | ND | 0.78 | ND | 1570 | <MDL |
| **Carmans River** | Golden Shiners | <MDL | <MDL | ND | <MDL | <MDL | <MDL | ND | 8.78 | <MDL | ND | 0.60 | ND | 900 | <MDL |
| | Brown Bullhead | 0.80 | <MDL | ND | <MDL | 0.79 | <MDL | <MDL | <MDL | <MDL | ND | 1.13 | <MDL | 1050 | <MDL |
| | Bluegill | <MDL | <MDL | ND | 0.65 | ND | <MDL | ND | 24.60 | <MDL | ND | 0.84 | ND | 1450 | <MDL |
| | Largemouth Bass | ND | <MDL | ND | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | ND | 1.01 | ND | 1320 | <MDL |
| | Pumpkinseed | <MDL | <MDL | ND | <MDL | 0.49 | <MDL | ND | <MDL | <MDL | ND | 0.89 | ND | 1480 | <MDL |
| **MDL** (varies by sample aliquot) | | 0.20 | 0.04 | 0.07 | 0.08 | 0.16 | 0.84 | 0.13 | 0.09 | 0.00 | 0.13 | 0.36 | 0.09 | 4.66 | 0.21 |

Notes:
See Figure 6-7 for sampling locations.
MDL = Minimum Detection Limit
NT = Not Tested
ND = Not Detected

**Table 6-8. Pesticides Analysis in Fish and Shellfish From the Peconic River System and Control Locations (CY 2000).**

| Location | Matrix | Dieldrin | 4,4'-DDE | 4,4'-DDD | 4,4'-DDT | gamma-Chlordane | alpha-Chlordane |
|---|---|---|---|---|---|---|---|
| | | μg/g (ppm) | | | | | |
| BNL HM-EA | Brown Bullhead | ND | ND | ND | ND | ND | ND |
| | Pumpkinseed | ND | ND | ND | ND | ND | ND |
| | Chain Pickerel | ND | ND | ND | ND | ND | ND |
| | Chubsucker | ND | ND | ND | ND | ND | ND |
| Peconic Bay | Clams | ND | ND | ND | ND | ND | ND |
| Flanders Bay | Clams | ND | ND | ND | ND | ND | ND |
| Indian Point | Mussels | ND | ND | ND | ND | ND | ND |
| Forge Pond | Mussels | ND | 0.027 | 0.006 | <MDL | <MDL | ND |
| Lloyd Harbor | Clams | ND | ND | ND | ND | ND | ND |
| Jamaica Bay | Clams | ND | ND | ND | ND | ND | ND |
| Forge Pond | Brown Bullhead | ND | 0.016 | <MDL | ND | ND | ND |
| | Pumpkinseed | ND | 0.009 | ND | <MDL | ND | ND |
| | Largemouth Bass | ND | 0.016 | <MDL | ND | ND | ND |
| Donahue's Pond | Brown Bullhead | ND | <MDL | <MDL | ND | ND | ND |
| | Largemouth Bass | ND | 0.020 | 0.008 | <MDL | ND | ND |
| | Pumpkinseed | <MDL | 0.017 | 0.008 | <MDL | ND | ND |
| Swan Pond | Pumpkinseed | ND | 0.039 | 0.022 | ND | ND | ND |
| | Brown Bullhead | ND | ND | ND | ND | ND | ND |
| | Largemouth Bass | ND | 0.018 | 0.012 | ND | ND | ND |
| Carmans River | Golden Shiners | ND | 0.066 | 0.028 | <MDL | <MDL | 0.004 |
| | Brown Bullhead | ND | 0.040 | 0.019 | <MDL | <MDL | 0.006 |
| | Bluegill | ND | 0.023 | 0.007 | <MDL | <MDL | <MDL |
| | Bass | ND | 0.054 | 0.018 | <MDL | ND | ND |
| | Pumpkinseed | ND | 0.059 | 0.013 | <MDL | ND | ND |

Notes:
See Figure 6-7 for sampling locations.
MDL = Minimum Detection Limit
ND = Not Detected

again sampled. Additionally sediment and/or water samples were obtained from Peconic Bay, Flanders Bay, and Indian Point. The results indicated that potassium-40 was the only radionuclide observed in marine or estuarine vegetation, water, and sediment. No BNL generated radionuclides have ever been detected in marine samples since 1992 when sampling began.

### 6.3.6 AQUATIC SHELLFISH, VEGETATION, WATER, AND SEDIMENT SAMPLING

Samples of freshwater mussels, vegetation, sediments, and water were taken at several locations within the Peconic River and the Carmans River (see Figure 6-8 and Table 6-10). Cesium-137 was detected at low levels in sediments from Swan Pond and Donahue's

**Table 6-9. PCB Analysis of Fish Sampled From the Peconic River at the Sewage Treatment Plant (CY 2000).**

| | BNL HM-EA | | | |
|---|---|---|---|---|
| PCB | Brown Bullhead | Pumpkin-seed | Chain Pickerel | Chubsucker |
| | μg/g (ppm) | | | |
| Aroclor-1016 | ND | ND | ND | ND |
| Aroclor-1221 | ND | ND | ND | ND |
| Aroclor-1232 | ND | ND | ND | ND |
| Aroclor-1242 | ND | ND | ND | ND |
| Aroclor-1248 | ND | ND | ND | ND |
| Aroclor-1254 | 2.050* | 0.59 | 1.340* | 1.130 |
| Aroclor-1260 | 0.956 | 0.425* | 0.602* | 0.383* |

Notes:
ND = Not Detected
*Estimated value based on lab qualifiers.

**Table 6-10. Radiological Analysis Results for Shellfish, Aquatic Vegetation, Water, and Sediments (CY 2000).**

| Location and Sample Type | K-40 pCi/g (wet weight) | Cs-137 pCi/g (wet weight) |
|---|---|---|
| **Peconic Bay** | | |
| Clams | 11.20 ± 1.62 | ND |
| Water | 211 ± 51 | ND |
| Sediments* | 13.50 ± 1.75 | <MDL |
| **Flanders Bay** | | |
| Clams | 11.60 ± 1.61 | ND |
| Water | 290 ± 54 | ND |
| **Indian Point** | | |
| Mussels | 8.01 ± 1.12 | ND |
| *Salicornia* | 18 ± 1.39 | ND |
| Water | 313 ± 57 | ND |
| Sediments* | 6.66 ± 1.12 | ND |
| **Connecticut Avenue** | | |
| Mussels | 1.60 ± 0.72 | ND |
| **Forge Pond** | | |
| Mussels | 1.11 ± 0.74 | ND |
| Aquatic vegetation | 0.83 ± 0.21 | 0.04 ± 0.01 |
| **Donahue's Pond** | | |
| Aquatic vegetation | 8.27 ± 2.12 | 0.71 ± 0.11 |
| Water | ND | ND |
| Sediments* | 3.69 ± 0.80 | 0.30 ± 0.06 |
| **Swan Pond** | | |
| Aquatic vegetation | 16.2 ± 1.35 | ND |
| Water | ND | ND |
| Sediments* | 1.56 ± 0.880 | 0.46 ± 0.14 |
| **Lower Lake, Carmans River[a]** | | |
| Aquatic vegetation | 8.95 ± 2.66 | ND |
| Water | ND | ND |
| Sediments* | 2.41 ± 0.46 | <MDL |
| **Lloyd Harbor[a]** | | |
| Clams | 13.3 ± 1.37 | ND |
| Water | ND | ND |
| Sediments* | 15.00 ± 0.87 | <MDL |
| **Jamaica Bay[a]** | | |
| Clams | 6.95 ± 1.27 | ND |

Notes:
See Figure 6-7 for locations.
All values shown with a 95% confidence interval.
MDL = Minimum Detection Limit
ND = Not Detected
* Sediment values are for dry weights.
[a]Background locations

Pond, and in aquatic vegetation from Forge Pond and Donahue's Pond. These levels were similar to what was seen in the fish at these locations.

### 6.3.7 VEGETATION SAMPLING

Farm vegetable sampling resumed in 2000. Samples were collected from area farms surrounding BNL as well as from an onsite garden (Figure 6-9). Samples were submitted for radiological analysis and the results are presented in Table 6-11. As in the past, no radionuclides attributable to BNL operations were observed in farm produce. A small level of cesium-137 (0.52 pCi/g [0.02 Bq/g]) was found in chard grown in the BNL garden. Potassium-40, which occurs naturally, was the only radionuclide detected in all of the farm produce sampled. BNL also established vegetation sampling of grassy vegetation (see Table 6-12) near air monitoring stations to support the surveillance monitoring associated with these points. Grassy vegetation was also sampled in lawn areas where geese tend to graze for comparison with goose fecal sampling (see section 6.3.3 above). Vegetation sampling is carried out to determine if depositional material is accumulating on plant surfaces and soils and whether there is uptake by the vegetation. In 2000, the only radionuclide found in grassy vegetation was cesium-137. The highest level of cesium-137, 0.65

**Figure 6-8. Sampling Freshwater Mussels From the Peconic River.**

pCi/g (0.02 Bq/g), was found at Station S6 near the former Hazardous Waste Facility which is known to have cesium contamination in the soils. The other two areas where cesium-137 was detected had levels slightly above the detection limit.

### 6.4 BASIN SEDIMENT SAMPLING

BNL sampled sediments in many of the recharge basins located onsite (see Figure 5-7, map of outfall locations). Basin sediment sampling occurs on a two-year cycle. Samples were taken to a depth of six inches and broken down into subsamples consisting of soils from 0 – 2, 2 – 4, and 4 – 6 inches in depth. Sediments were analyzed for volatile organic compounds, semivolatile organic compounds, polychlorinated biphenols (PCBs), metals, and gamma emitting radionuclides. The subsections below describe the sampling results.

#### 6.4.1 ORGANIC ANALYSIS OF BASIN SEDIMENTS

Analysis of basin sediments showed no evidence of volatile organic compounds. However, two basins, the Central Steam Facility (CSF), and the channel leading to Basin HN had detectable levels of several semivolatile organic compounds that result from the breakdown of road oils. Table 6-13 presents the data on those areas with detected levels of the semivolatile organic compounds present. All compounds are well below the cleanup objectives published by Suffolk County Department of Health Services under Article 12 of the Suffolk County Sanitary Code with the exception of chrysene that was found at the CSF outfall. Chrysene was detected at a maximum of 600 ppb at a depth of 4 – 6 inches at this outfall. However, this level is below the 800 ppb action level set by Suffolk County Article 12 standards for cleanup.

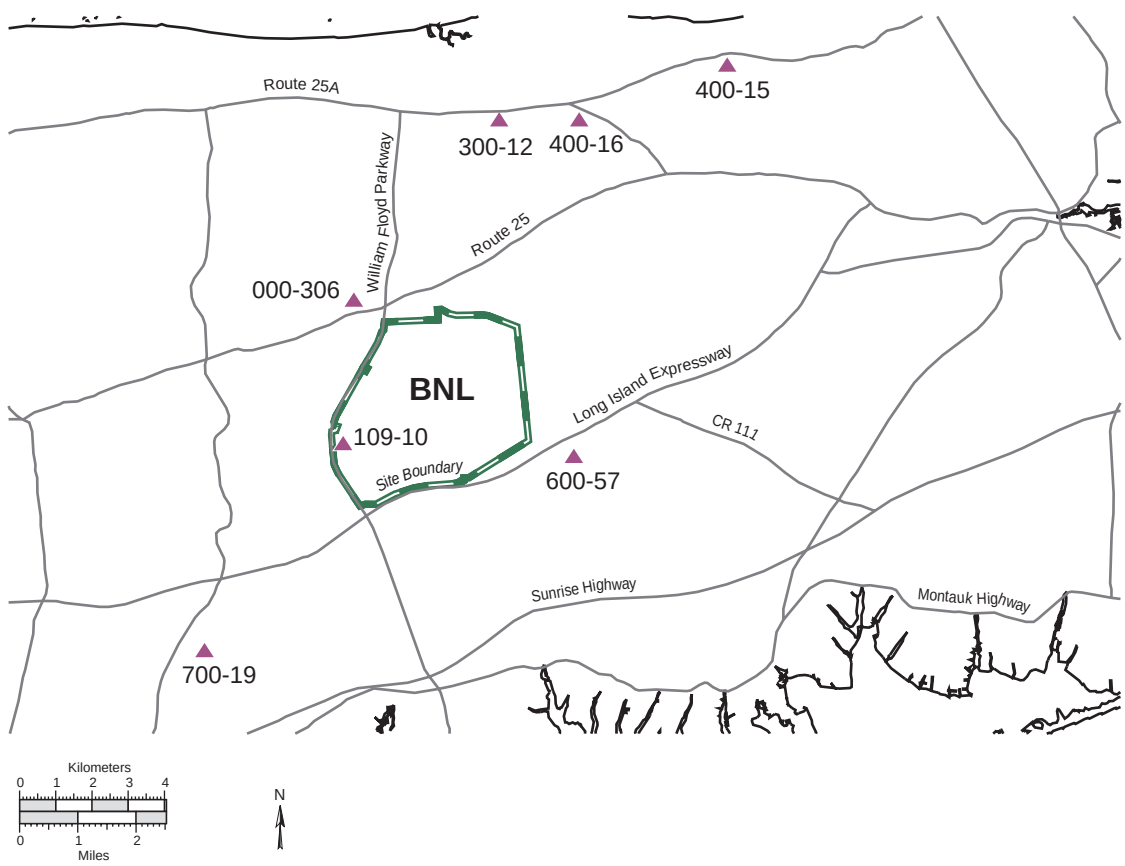


**Figure 6-9. Farm and Garden Sampling Locations.**

**Table 6-11. Radiological Analysis of Farm and Garden Produce (CY 2000).**

| Location | | K-40 pCi/g (wet weight) | Cs-137 pCi/g (wet weight) |
|---|---|---|---|
| **BNL - Garden** | Chard | 0.21 ± 0.05 | 0.52 ± 0.27 |
| | Yellow squash | 1.31 ± 0.22 | ND |
| | Tomato | 1.38 ± 0.22 | ND |
| | Cucumber | 3.22 ± 0.55 | ND |
| | Lettuce | 4.23 ± 1.01 | ND |
| | Tomato | 1.70 ± 0.27 | ND |
| | Sunflower | 2.03 ± 0.47 | ND |
| | Corn | 2.00 ± 0.66 | ND |
| **BNL-Vegetation** | | | |
| N. of Berkner | Apple | 0.91 ± 0.16 | ND |
| Biology Field | Corn | 2.96 ± 0.99 | ND |
| **Lewins Farm** | Strawberry | 2.59 ± 0.69 | ND |
| | Potato | 5.80 ± 1.19 | ND |
| | Potato* | 3.88 ± 0.85 | ND |
| | Yellow squash | 1.77 ± 0.34 | ND |
| | Yellow squash* | 3.82 ± 0.75 | ND |
| | Cucumber | 1.10 ± 0.18 | ND |
| | String bean | 1.97 ± 0.33 | ND |
| | Peach | 1.32 ± 0.21 | ND |
| | Cauliflower | 2.87 ± 0.46 | ND |
| | Broccoli | 6.89 ± 1.40 | ND |
| | Pumpkin | 2.44 ± 0.47 | ND |
| | Apple | 0.92 ± 0.16 | ND |
| | Apple* | 0.76 ± 0.13 | ND |
| **Edwards Ave.** | Strawberry | 0.27 ± 0.07 | ND |
| **Lenny Bruno's Farm** | Pepper | 1.86 ± 0.31 | ND |
| | Cucumber | 1.90 ± 0.42 | ND |
| | Tomato | 1.46 ± 0.24 | ND |
| | String bean | 1.84 ± 0.40 | ND |
| | Zuchini | 2.28 ± 0.37 | ND |
| **May's Farm** | Cabbage | 1.54 ± 0.34 | ND |
| | Pumpkin | 2.58 ± 0.38 | ND |
| | Cauliflower | 2.48 ± 0.53 | ND |
| | Broccoli | 3.29 ± 0.54 | ND |
| **Cornell Cooperative** | Corn | 1.81 ± 0.38 | ND |
| | Corn* | 2.70 ± 0.89 | ND |

Notes:
See Figure 6-9 for sampling locations.
All values shown with a 95% confidence interval.
ND = Not Detected
*Duplicate Sample

**Table 6-12. Radiological Analysis of Grassy Vegetation (CY 2000).**

| Location | K-40 pCi/g, (wet weight) | Cs-137 pCi/g (wet weight) |
|---|---|---|
| **BNL** | | |
| E. of Bldg. 490 | 4.93 ± 1.14 | ND |
| W. Ballfield | 20.26 ± 8.34 | ND |
| Weaver Rd. | 2.39 ± 0.61 | 0.05 ± 0.02 |
| P4 area | 3.04 ± 0.57 | ND |
| S6 area | 15.96 ± 3.93 | 0.65 ± 0.27 |
| P7 area | ND | ND |
| S5 area | 3.92 ± 0.68 | 0.02 ± 0.01 |
| P2 | 1.11 ± 0.32 | ND |
| P9 | 9.47 ± 2.66 | ND |
| Lawrence & Rutherford | 3.94 ± 0.90 | ND |
| Bldg. 464 | 16.60 ± 4.66 | ND |
| **Spring Lake, Middle Island*** | 3.92 ± 0.72 | ND |
| **NYSDEC Checkstation, Ridge** | 2.24 ± 0.55 | ND |

Notes:
All values shown with a 95% confidence interval.
ND = Not Detected
*Control location

Basin sediments also showed the presence of PCBs in Basins HS and HW. Table 6-14 gives the results of PCB analysis for these two basins. Both basins have Aroclor 1254 and Aroclor 1260. Aroclor 1260 was present at the highest levels, 2200 ppb, in Basin HW at a depth of 4 – 6 inches. These two basins have historic evidence of PCBs and were investigated under BNL's CERCLA remedial investigation/feasibility studies. The levels seen were and continue to be below the action levels for cleanup set by Suffolk County Article 12. Since these two basins are within the interior portions of the Laboratory they are considered to have restricted access. These two basins will continue to be sampled periodically and monitored for the PCB levels.

### 6.4.2 METALS ANALYSIS OF BASIN SEDIMENTS

Results of metals analysis in the basins are presented in Table 6-15. The results show that metals are mostly below the minimum detection limit in most basins at all depths and are below any standards requiring cleanup, or are below established health standards. There are

**Table 6-13. Semivolatile Organic Compound Analysis Results for Basin Sediments (CY 2000).**

| Semivolatile Organic Compound | HS Basin | HW Basin | | HX West | CSF | | | HN Channel |
|---|---|---|---|---|---|---|---|---|
| | 4 - 6" | 0 -2" | 2 - 4" | 4 - 6" | 0 -2" | 2 - 4" | 4 - 6" | 0 -2" |
| | µg/kg (ppb) | | | | | | | |
| 3-Methylphenol/4-Methylphenol | ND | 1200 | <MDL | ND | ND | ND | ND | ND |
| Phenanthrene | <MDL | <MDL | <MDL | 400 | 420 | 460 | 480 | <MDL |
| Fluoranthene | 420 | 750 | 610 | <MDL | 810 | 870 | 1100 | 1000 |
| Pyrene | <MDL | 570 | <MDL | <MDL | 520 | 640 | 780 | 740 |
| Benzo[a]anthracene | <MDL | <MDL | <MDL | <MDL | 380 | 410 | 500 | <MDL |
| Chrysene | <MDL | <MDL | <MDL | <MDL | 450 | 500 | 600 | <MDL |
| bis(2Ethylhexyl)phthalate | <MDL | 720 | <MDL | ND | 450 | 580 | 680 | 770 |
| Benzo[b]fluoroanthene | <MDL | <MDL | <MDL | <MDL | 370 | 480 | 490 | <MDL |
| Benzo[k]fluoranthene | <MDL | <MDL | <MDL | <MDL | 380 | <MDL | 580 | <MDL |
| Benzo[a]pyrene | <MDL | <MDL | <MDL | <MDL | <MDL | 380 | 440 | <MDL |

Notes:
See Chapter 5, Figure 5-7 for basin locations.
Only chemicals for which there was at least one detection are listed on this table.
MDL = Minimum Detection Limit
ND = Not Detected

**Table 6-14. PCB Analysis Results of Basin Sediments (CY 2000).**

| PCB | Basin HS | | | Basin HW | | |
|---|---|---|---|---|---|---|
| | 0 -2" | 2 - 4" | 4 - 6" | 0 -2" | 2 - 4" | 4 - 6" |
| | µg/kg (ppb) | | | | | |
| Aroclor-1016 | ND | ND | ND | ND | ND | ND |
| Aroclor-1221 | ND | ND | ND | ND | ND | ND |
| Aroclor-1232 | ND | ND | ND | ND | ND | ND |
| Aroclor-1242 | ND | ND | ND | ND | ND | ND |
| Aroclor-1248 | ND | ND | ND | ND | ND | ND |
| Aroclor-1254 | 160 | 98 | 170 | 730 | 360* | ND |
| Aroclor-1260 | 67 | 44 | 74 | 1600 | 2000 | 2200 |

Notes:
See Chapter 5, Figure 5-7 for basin locations.
ND = Not Detected
* Estimated value based on lab qualifiers.

exceptions to be noted. Several metals are at levels that are above cleanup objectives, but below regulatory action levels requiring cleanup. Those metals with the highest level detected and location are cadmium (5.4 ppm at the CSF, 4 - 6″ depth), copper (253 ppm at the CSF, 4 - 6″ depth), mercury (0.59 ppm at Basin HW, 0 - 2″ depth), and nickel (419 ppm at the CSF, 4 - 6″ depth). Although not above cleanup standards, vanadium was detected at the CSF outfall at levels higher than at any other sampling location. The likely source for these high values is boiler washout as vanadium is a common by-product of oil combustion. In addition to the previously mentioned metals, lead was found at the CSF outfall above cleanup action levels. The highest level of lead observed was 8,600 ppm in soils located in the sample interval 4 – 6 inches deep. This level is higher than has been seen in the past at this location. BNL intends to conduct further sampling in 2001 in the area of the CSF outfall to better delineate the extent of the lead in sediments.

#### 6.4.3 RADIOLOGICAL ANALYSIS OF BASIN SEDIMENTS

Radiological analysis of basin sediments was conducted to detect gamma-emitting radionuclides. Table 6-16 lists the basins and radionuclides detected at the various depths. All radionuclides detected are either naturally occurring or were at levels that are considered to be background. Those radionuclides that are anthropogenic in nature are cobalt-60 and cesium-137. Cobalt-60 contamination is likely a result of past operations at BNL, but levels were lower than action levels and do not require remediation. Cesium-137 is likely a result of worldwide fallout from past aboveground nuclear weapons testing. Beryl-

**Table 6-15. Metals Analysis Results of Basin Sediments (CY 2000).**

| | HO East | | | HP West | | | HS | | | HW | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 - 2" | 2 - 4" | 4 - 6" | 0 - 2" | 2 - 4" | 4 - 6" | 0 - 2" | 2 - 4" | 4 - 6" | 0 - 2" | 2 - 4" | 4 - 6" |
| **Metal** | mg/kg (ppm) | | | | | | | | | | | |
| Aluminum | 617 | 462 | 497 | 577 | 633 | 817 | 3750 | 4520 | 4960 | 7290 | 4330 | 6310 |
| Antimony | <MDL | <MDL | ND | ND | <MDL | ND | ND | ND | ND | <MDL | ND | <MDL |
| Arsenic | <MDL | <MDL | ND | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Barium | <MDL | <MDL | <MDL | 144 | 45.6 | 23.8 | <MDL | 13.8 | <MDL | <MDL | <MDL | 28.5 |
| Beryllium | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Cadmium | <MDL | ND | ND | <MDL | ND | ND | <MDL | <MDL | <MDL | 2.8 | 1.3 | <MDL |
| Calcium | 1890 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | 1630 | 687 | 728 |
| Chromium | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Cobalt | <MDL | <MDL | <MDL | 6.1 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Copper | 6.3 | 3.2 | 3.2 | 32.1 | 14.1 | 10.8 | 11.5 | 11.3 | 13 | 48.9 | 21.4 | 13.8 |
| Iron | 3370 | 2180 | 1700 | 6740 | 3360 | 2600 | 4000 | 7080 | 5410 | 9080 | 5270 | 6820 |
| Lead | 1.8 | 2.2 | 1.1 | 2.2 | 1.5 | 2.1 | 15.3 | 16.9 | 16.6 | 106 | 51.5 | 49.1 |
| Magnesium | 1200 | <MDL | <MDL | <MDL | <MDL | <MDL | 654 | 897 | 875 | 1400 | 716 | 758 |
| Manganese | 183 | 117 | 104 | 1690 | 445 | 239 | 46.1 | 63.2 | 64.6 | 71 | 38.6 | 53.3 |
| Mercury | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.59 | 0.22 | ND |
| Nickel | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | 5.1 | 5 | 15.9 | 7.8 | 6.7 |
| Potassium | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Selenium | <MDL | ND | ND | 0.94 | <MDL | <MDL | ND | <MDL | ND | <MDL | <MDL | <MDL |
| Silver | <MDL | <MDL | <MDL | <MDL | <MDL | 0.11 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Sodium | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | 46.9 | <MDL | <MDL | <MDL |
| Thalium | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Vanadium | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | 9.3 | 16.1 | 12.3 | 28.4 | 14.9 | 16.2 |
| Zinc | 10.8 | 6.8 | 6.9 | 6.7 | 3.7 | 4.5 | 63 | 63.7 | 68.6 | 233 | 107 | 56.1 |

| | HX West | | | CSF | | | HN Channel | | | HN Center Basin | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 - 2" | 2 - 4" | 4 - 6" | 0 - 2" | 2 - 4" | 4 - 6" | 0 - 2" | 2 - 4" | 4 - 6" | 0 - 2" | 2 - 4" | 4 - 6" |
| **Metal** | mg/kg (ppm) | | | | | | | | | | | |
| Aluminum | 655 | 609 | 457 | 5990 | 7500 | 9400 | 5490 | 2100 | 1270 | 2200 | 1370 | 1180 |
| Arsenic | <MDL | ND | ND | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Barium | <MDL | <MDL | <MDL | 114 | 161 | 346 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Beryllium | <MDL | <MDL | <MDL | <MDL | <MDL | 0.66 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Cadmium | ND | ND | ND | 1.9 | 2.5 | 5.4 | <MDL | <MDL | ND | <MDL | ND | ND |
| Calcium | <MDL | <MDL | <MDL | 2090 | 2880 | 4970 | 3930 | 1180 | <MDL | <MDL | <MDL | <MDL |
| Chromium | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Cobalt | <MDL | <MDL | <MDL | 9 | 12.8 | 22.9 | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Copper | 3.5 | <MDL | <MDL | 80.7 | 120 | 253 | 192 | 61.1 | 27.4 | 35.8 | 14.4 | 5.8 |
| Iron | 3760 | 1650 | 1160 | 9210 | 13400 | 19800 | 9010 | 4200 | 3260 | 3360 | 2980 | 2340 |
| Lead | 1.9 | 1.1 | 0.7 | 3380 | 3420 | 8600 | 53.7 | 15.8 | 7.7 | 11.4 | 6.2 | 2.5 |
| Magnesium | <MDL | <MDL | <MDL | 1480 | 2080 | 3850 | 2840 | 865 | <MDL | 581 | <MDL | <MDL |
| Manganese | 82.3 | 37.3 | 22 | 134 | 180 | 275 | 82.3 | 40.4 | 38.6 | 33.1 | 43.5 | 26.2 |
| Mercury | ND | ND | ND | 0.13 | 0.17 | 0.34 | <MDL | ND | ND | ND | ND | ND |
| Nickel | <MDL | <MDL | <MDL | 151 | 226 | 419 | 11.2 | <MDL | <MDL | <MDL | <MDL | <MDL |
| Potassium | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Selenium | <MDL | ND | ND | 0.65 | 1.1 | 1.4 | 1.1 | <MDL | <MDL | ND | <MDL | <MDL |
| Silver | <MDL | <MDL | ND | <MDL | <MDL | <MDL | <MDL | <MDL | ND | <MDL | <MDL | ND |
| Sodium | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL | <MDL |
| Thalium | ND | ND | ND | ND | ND | ND | <MDL | ND | ND | ND | ND | ND |
| Vanadium | <MDL | <MDL | <MDL | 535 | 674 | 1530 | 21.8 | <MDL | <MDL | 6.8 | <MDL | <MDL |
| Zinc | 3 | <MDL | <MDL | 280 | 373 | 776 | 382 | 128 | 54.3 | 50.4 | 19.2 | 12.5 |

Notes:
See Chapter 5, Figure 5-7 for basin locations.
MDL = Minimum Detection Limit
ND = Not Detected
Light shading = Samples with levels above cleanup objectives but below cleanup action levels.
Dark shading = Samples with levels above cleanup action levels.

lium levels seen in basin sediments is naturally occurring and originates from atmospheric ionization resulting from solar flare activity. Beryllium-7 is also noted in precipitation data discussed below in Section 6.5.

### 6.5 SOIL SAMPLING

Soil sampling was expanded in 2000. Historically soil samples were obtained at farm locations where farm produce was collected. This practice continued in 2000 with the addition of soil sampling at locations where grassy vegetation was sampled. Since many of the soil sampling points are in the vicinity of air monitoring stations, the sampling of soil and vegetation supports air monitoring. Over time, soil sampling may provide indications of deposition of potential radiological contaminants. Soil samples were analyzed for gamma emitting radionuclides. Table 6-17 is provided to show the sampling results of the radiological analysis of soils. All radionuclides detected, with the exception of cesium-137, are found naturally in Long Island soils. Higher levels of some of the radionuclides, such as lead-212, lead-214, bismuth-214, and potassium-40, in some of the farm locations are likely due to the addition of fertilizers to soils for growing crops. Cesium-137 concentrations were below 0.50 pCi/g (0.02 Bq/g) at all locations. These levels are considered to be background resulting from worldwide fallout from historic aboveground nuclear weapons testing.

### 6.6 TOXICITY TESTING AT THE SEWAGE TREATMENT PLANT

Under the State Pollutant Discharge Elimination System discharge permit, BNL conducted toxicity testing for the Sewage Treatment Plant effluent. Two species of fish are evaluated - the fathead minnow (*Pimephales promelas*) and the water flea (*Ceriodaphnia dubia*). Results from this testing program are presented in Chapter 3.

### 6.7 PRECIPITATION MONITORING

As part of the Environmental Monitoring Program, precipitation samples were collected approximately quarterly at air monitoring Stations P4 and S5 (see Chapter 4, Figure 4-4 for station locations) and analyzed for radiological content. Four samples were taken from each of these two stations in 2000. Gross alpha activity measurements above the minimum detection limit were found in samples taken in August and November. The samples from the P4 location showed a maximum of 2.82 pCi/L activity, while the samples from the S5 location had a maximum activity level of 5.49 pCi/L. Both of these values are within the range of historic values reported for gross alpha activity. Gross beta activity was measured in four samples at each of the sampling locations. Location P4 had a maximum activity level of 48.30 pCi/L, with an average of 16.87 pCi/L. Location S5 had a maximum of 87.00 pCi/L, with the average activity of 29.07 pCi/L. Gross beta activity values were within the range of values historically observed at these two locations. Tritium was not detected in any of the samples from either location. Gamma analysis of samples taken in April and August showed the presence of beryllium-7 at a maximum of 52.2 pCi/L at Station P4 in April and 37.4 pCi/L in August at Station S5. Beryllium-7 is a naturally occurring radionuclide resulting from solar flare activity.

### 6.8 WILDLIFE MANAGEMENT EDUCATION, OUTREACH, AND RESEARCH

BNL sponsors a variety of educational and outreach activities on natural resources. These programs are designed to provide an understanding of the ecosystem and foster interest in science. They are conducted at the Laboratory in collaboration with DOE, local agencies, colleges, and local high schools. Ecological research is also conducted onsite to update the current natural resources inventory, gain a better understanding of the ecosystem, and guide management planning.

In 2000, the Environmental Services Division (ESD) hosted two student fellowships, one during the spring and one during the summer. Both students were from Puerto Rico and both conducted research on the tiger salamander. The data gained from their studies has furthered BNL's understanding of the distribution and reproductive success of the tiger salamanders located on BNL property. One of the students was also responsible for the development of BNL's Natural Resources webpage located at <http://www.bnl.gov/wildlife/> (see Figure 6-10). The information provided on this web page gives the reader a broad understanding of the natural resources found at BNL.

**Table 6-16. Radiological Analysis Results of Basin Sediments (CY 2000).**

| Location and Sample Depth | Be-7 pCi/g (dry) | K-40 pCi/g (dry) | Co-60 pCi/g (dry) | Cs-137 pCi/g (dry) | Tl-208 pCi/g (dry) | Pb-212 pCi/g (dry) | Bi-214 pCi/g (dry) | Pb-214 pCi/g (dry) | Ac-228 pCi/g (dry) | Th-232 pCi/g (dry) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Basin HO East** | | | | | | | | | | |
| 0 - 2" | ND | ND | ND | 0.03 ± 0.03 | 0.13 ± 0.04 | 0.38 ± 0.06 | ND | 0.34 ± 0.06 | 0.37 ± 0.07 | 0.35 ± 0.16 |
| 2 - 4" | ND | 1.57 ± 1.34 | ND | ND | ND | ND | ND | 0.41 ± 0.19 | ND | ND |
| 4 - 6" | ND | 2.32 ± 1.02 | ND | ND | 0.12 ± 0.07 | 0.25 ± 0.11 | ND | ND | ND | ND |
| **Basin HP West** | | | | | | | | | | |
| 0 - 2" | ND | 2.95 ± 0.59 | ND | ND | 0.25 ± 0.05 | 0.72 ± 0.11 | 0.91 ± 0.11 | 0.90 ± 0.12 | 1.02 ± 0.14 | 1.31 ± 0.37 |
| 2 - 4" | ND | 2.67 ± 0.55 | ND | ND | 0.15 ± 0.04 | 0.40 ± 0.07 | 0.35 ± 0.07 | 0.40 ± 0.07 | 0.42 ± 0.08 | 0.65 ± 0.21 |
| 4 - 6" | ND | 3.19 ± 0.63 | ND | ND | 0.11 ± 0.03 | 0.35 ± 0.06 | 0.24 ± 0.05 | 0.25 ± 0.05 | 0.36 ± 0.07 | ND |
| **Basin HS Basin** | | | | | | | | | | |
| 0 - 2" | 1.47 ± 0.42 | 5.29 ± 0.99 | ND | 0.16 ± 0.05 | 0.14 ± 0.05 | 0.46 ± 0.09 | ND | 0.32 ± 0.13 | 0.47 ± 0.10 | 0.44 ± 0.23 |
| 2 - 4" | 0.40 ± 0.17 | ND | ND | 0.11 ± 0.03 | 0.13 ± 0.03 | 0.40 ± 0.07 | ND | 0.31 ± 0.11 | 0.40 ± 0.08 | 0.43 ± 0.18 |
| 4 - 6" | ND | 5.69 ± 1.99 | ND | ND | 0.37 ± 0.15 | 0.93 ± 0.26 | 0.81 ± 0.22 | 0.82 ± 0.25 | ND | ND |
| **Basin HW Basin** | | | | | | | | | | |
| 0 - 2" | 1.31 ± 0.91 | 5.00 ± 1.49 | ND | 0.21 ± 0.09 | 0.23 ± 0.11 | 0.42 ± 0.18 | ND | 0.62 ± 0.17 | ND | ND |
| 2 - 4" | ND | 4.89 ± 0.89 | ND | 0.14 ± 0.04 | 0.19 ± 0.05 | 0.63 ± 0.10 | 0.46 ± 0.08 | 0.48 ± 0.13 | 0.60 ± 0.10 | 0.72 ± 0.27 |
| 4 - 6" | ND | 4.66 ± 0.85 | ND | 0.12 ± 0.04 | 0.24 ± 0.05 | 0.64 ± 0.10 | 0.51 ± 0.08 | 0.62 ± 0.08 | 0.56 ± 0.09 | 0.67 ± 0.24 |
| **Basin HX West** | | | | | | | | | | |
| 0 - 2" | ND | 1.58 ± 0.46 | ND | ND | 0.08 ± 0.03 | 0.23 ± 0.07 | ND | 0.19 ± 0.06 | ND | ND |
| 2 - 4" | ND | ND | ND | ND | 0.05 ± 0.02 | 0.17 ± 0.04 | ND | 0.16 ± 0.05 | ND | ND |
| 4 - 6" | ND | 2.11 ± 1.14 | ND | ND | ND | ND | ND | ND | ND | ND |
| **CSF** | | | | | | | | | | |
| 0 - 2" | ND | 4.28 ± 1.63 | ND | 0.39 ± 0.11 | 0.25 ± 0.13 | 0.55 ± 0.17 | ND | 0.48 ± 0.17 | ND | ND |
| 2 - 4" | ND | 4.65 ± 0.86 | ND | 0.22 ± 0.05 | 0.19 ± 0.05 | 0.60 ± 0.10 | 0.47 ± 0.08 | 0.54 ± 0.09 | 0.49 ± 0.11 | ND |
| 4 - 6" | ND | 5.13 ± 0.91 | ND | 0.24 ± 0.05 | 0.18 ± 0.04 | 0.61 ± 0.09 | 0.49 ± 0.08 | 0.58 ± 0.09 | 0.60 ± 0.10 | 0.68 ± 0.25 |
| **HN Channel** | | | | | | | | | | |
| 0 - 2" | 2.02 ± 0.47 | 3.95 ± 0.73 | 0.12 ± 0.02 | 0.23 ± 0.05 | 0.14 ± 0.04 | 0.46 ± 0.08 | 0.28 ± 0.06 | 0.37 ± 0.07 | 0.51 ± 0.09 | 0.50 ± 0.20 |
| 2 - 4" | 0.27 ± 0.19 | 2.50 ± 0.52 | 0.04 ± 0.02 | 0.06 ± 0.03 | 0.17 ± 0.04 | 0.42 ± 0.07 | 0.25 ± 0.05 | 0.25 ± 0.05 | 0.42 ± 0.08 | 0.44 ± 0.22 |
| 4 - 6" | ND | 2.75 ± 0.61 | ND | ND | 0.11 ± 0.04 | 0.37 ± 0.08 | ND | 0.20 ± 0.13 | ND | ND |
| **Basin HN Center** | | | | | | | | | | |
| 0 - 2" | 0.99 ± 0.30 | 3.39 ± 0.72 | 0.06 ± 0.02 | 0.03 ± 0.03 | 0.15 ± 0.05 | 0.39 ± 0.07 | ND | 0.21 ± 0.11 | ND | ND |
| 2 - 4" | ND | ND | ND | ND | 0.10 ± 0.03 | 0.34 ± 0.06 | ND | 0.15 ± 0.09 | 0.34 ± 0.08 | ND |
| 4 - 6" | ND | 2.73 ± 1.42 | ND | ND | 0.27 ± 0.12 | 0.56 ± 0.24 | ND | ND | ND | ND |

Notes:
See Chapter 5, Figure 5-7 for basin locations.
All values shown with a 95% confidence interval.
ND = Not Detected

**Table 6-17. Radiological Analysis Results of Soil Samples (CY 2000).**

| Location | K-40 pCi/g (dry weight) | Cs-137 pCi/g (dry weight) | Tl-208 pCi/g (dry weight) | Bi-212 pCi/g (dry weight) | Pb-212 pCi/g (dry weight) | Bi-214 pCi/g (dry weight) | Pb-214 pCi/g (dry weight) | Ac-228 pCi/g (dry weight) | Th-232 pCi/g (dry weight) |
|---|---|---|---|---|---|---|---|---|---|
| **BNL** | | | | | | | | | |
| Garden | 3.91 ± 0.79 | 0.28 ± 0.06 | 0.19 ± 0.05 | ND | 0.49 ± 0.09 | 0.34 ± 0.07 | 0.34 ± 0.07 | ND | ND |
| Bldg. 464 Lawn | 5.63 ± 1.65 | 0.35 ± 0.13 | 0.36 ± 0.12 | ND | 0.77 ± 0.18 | ND | 0.73 ± 0.21 | ND | ND |
| Bldg. 490 Lawn | 4.93 ± 0.90 | 0.20 ± 0.05 | 0.20 ± 0.04 | 0.51 ± 0.21 | 0.65 ± 0.10 | 0.56 ± 0.09 | 0.48 ± 0.08 | 0.72 ± 0.11 | 0.68 ± 0.27 |
| Weaver Dr. | 5.72 ± 1.01 | 0.27 ± 0.06 | 0.26 ± 0.06 | 0.66 ± 0.20 | 0.64 ± 0.10 | 0.53 ± 0.08 | 0.58 ± 0.09 | 0.70 ± 0.10 | 1.01 ± 0.29 |
| West Ballfields | 7.21 ± 1.25 | 0.27 ± 0.05 | 0.29 ± 0.06 | 0.58 ± 0.19 | 0.85 ± 0.12 | 0.66 ± 0.09 | 0.72 ± 0.10 | 0.76 ± 0.11 | 0.78 ± 0.28 |
| Lawrence and Rutherford | 4.08 ± 1.43 | 0.28 ± 0.09 | 0.23 ± 0.11 | ND | 0.51 ± 0.20 | ND | 0.41 ± 0.16 | ND | ND |
| Biology Fields | 7.38 ± 1.26 | 0.17 ± 0.04 | 0.28 ± 0.05 | ND | 0.87 ± 0.13 | 0.58 ± 0.08 | 0.58 ± 0.09 | 0.85 ± 0.11 | 1.00 ± 0.30 |
| P4 | 4.67 ± 0.85 | 0.09 ± 0.03 | 0.21 ± 0.05 | ND | 0.66 ± 0.10 | 0.46 ± 0.07 | 0.53 ± 0.08 | 0.59 ± 0.10 | 0.74 ± 0.30 |
| S6 | 3.88 ± 0.73 | 0.09 ± 0.04 | 0.17 ± 0.04 | ND | 0.46 ± 0.08 | 0.32 ± 0.07 | 0.37 ± 0.07 | ND | 0.61 ± 0.20 |
| P7 | 7.86 ± 1.98 | 0.10 ± 0.07 | 0.30 ± 0.12 | ND | 0.84 ± 0.18 | ND | ND | ND | 1.10 ± 0.66 |
| S5 | 3.19 ± 0.68 | 0.19 ± 0.05 | 0.19 ± 0.05 | ND | 0.38 ± 0.09 | ND | 0.30 ± 0.10 | ND | 0.52 ± 0.23 |
| P2 | 2.89 ± 0.61 | ND | 0.11 ± 0.03 | ND | 0.35 ± 0.06 | 0.23 ± 0.05 | 0.20 ± 0.05 | 0.28 ± 0.06 | 0.33 ± 0.19 |
| P9 | ND | ND | 0.21 ± 0.05 | 0.61 ± 0.16 | 0.69 ± 0.11 | 0.44 ± 0.08 | 0.43 ± 0.12 | 0.67 ± 0.09 | 0.71 ± 0.18 |
| **Offsite** | | | | | | | | | |
| Bruno Farm | 7.53 ± 1.95 | 0.31 ± 0.16 | 0.40 ± 0.16 | ND | 1.00 ± 0.31 | ND | 0.72 ± 0.25 | ND | ND |
| Cornell Coop | 10.20 ± 2.52 | 0.50 ± 0.22 | 0.67 ± 0.24 | ND | 2.22 ± 0.52 | 1.57 ± 0.34 | 1.48 ± 0.33 | 2.02 ± 0.56 | ND |
| May's Farm | 5.06 ± 0.89 | 0.09 ± 0.03 | 0.26 ± 0.06 | 0.51 ± 0.17 | 0.84 ± 0.12 | 0.53 ± 0.08 | 0.53 ± 0.16 | 0.68 ± 0.10 | 0.79 ± 0.31 |
| Lewin Farm | 6.83 ± 1.25 | ND | 0.34 ± 0.07 | ND | 0.98 ± 0.16 | 0.68 ± 0.12 | 0.66 ± 0.16 | 0.99 ± 0.16 | 0.80 ± 0.38 |
| NYSDEC Game Farm | 3.66 ± 0.69 | 0.08 ± 0.03 | 0.19 ± 0.04 | ND | 0.52 ± 0.08 | 0.39 ± 0.07 | 0.41 ± 0.07 | 0.54 ± 0.10 | 0.60 ± 0.23 |

Notes:
All values shown with a 95% confidence interval.
ND = Not Detected

**Figure 6-10. Neftali Hernandez Presenting ESD's New Natural Resources Webpage.**

In addition to hosting student fellowships, members of ESD and other departments volunteer as speakers and give guest lectures at schools and civic groups. ESD also hosted activities in association with the thirtieth Anniversary of Earth Day in 2000 and provided activities to educate Laboratory employees and the general public on the environment and conservation. BNL hosted the Fifth Annual Pine Barrens Research Forum in October providing a venue for researchers conducting work on pine barrens ecosystems to share their results and interact with each other.

### 6.9 CULTURAL RESOURCE MANAGEMENT ACTIVITIES

The cultural resource management program is being developed to ensure that the Laboratory fully complies with the numerous cultural resource requirements. In 2000, BNL developed a work plan that will guide the development of a formal Cultural Resources Management Plan, that in turn will guide the management of all of BNL's cultural resources. These resources include World War I trenches, Civilian Conservation Corps features such as the white pine groves, World War II buildings, and historic structures associated with high-energy physics and other science conducted at the Laboratory.

In 2000, BNL received concurrence from the New York State Historic Preservation Officer (NYSHPO) that the Brookhaven Graphite Research Reactor (BGRR) Complex was eligible for inclusion in the National Register of Historic Places. Because this complex is undergoing decontamination and decommissioning, it is likely that some features of this complex may be adversely affected by the decontamination and decommissioning activities. Therefore, DOE and the NYSHPO entered into a Memorandum of Agreement to mitigate the potential negative effects of the decontamination and decommissioning process. This Memorandum of Agreement specifies the development of a history video about the BGRR, a researchers guide, and, pending funding, an interactive CD-ROM. The BGRR history video and the archiving of BGRR related documents began in 2000 and will continue in 2001.

Section 110 of the National Historic Preservation Act requires that government agencies conduct surveys of their properties to identify those buildings, structures, and features that are potentially eligible for inclusion in the National Register of Historic Places. In 2000, BNL established a contract with the Institute for Long Island Archaeology located at the State University of New York at Stony Brook to conduct a building-by-building survey of all 440 buildings located at BNL. The results of this survey should be available early in 2001.

In the course of fieldwork related to the natural resources program, additional World War I trenches were identified. These trenches were used as part of the training necessary to prepare the American Expeditionary Forces for battle in Europe during World War I. The trenches located at BNL may be the only remaining training trenches in the United States from that era.

BNL also began developing its *Site Master Plan* for future development at the Laboratory. As part of this plan an area was selected for the development of a Camp Upton Historic Museum Complex. This complex would house artifacts and buildings from both World War I and World War II Camp Upton, as well as information from the Civilian Conservation Corp. The proposed Camp Upton Historic Museum Complex was formally recognized on November 30, 2000 as a Save America's Treasures project, which is a White House Millennium Council initiative. With this designation, the project is eligible to compete for matching funds in support of its development.

With the permanent shut down of the High Flux Beam Reactor (HFBR) in November 1999, BNL began placing the reactor into a safe and secure shut down configuration. As part of this process, discussions began about the significant scientific achievements the HFBR contributed to science, its unique design, and its place in the BNL landscape. As a result of these discussions, the High Flux Beam Reactor was thought to be of major significance and the paperwork required under Section 106 of the National Historic Preservation Act was initiated to determine whether this facility was eligible for inclusion in the National Register of Historic Places. The paperwork was being finalized for submission to DOE at the close of 2000 and will likely be submitted to the NYSHPO in 2001.

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The Brookhaven National Laboratory Groundwater Protection Management Program is made up of four elements: prevention, monitoring, restoration, and communication. In addition to implementing aggressive pollution prevention measures to protect groundwater resources, BNL has established an extensive groundwater monitoring well network to verify that prevention and restoration activities are effective. In 2000, BNL collected groundwater samples from 683 monitoring wells during 2,530 individual sampling events. Six volatile organic compound plumes and eight radionuclide plumes were tracked. During 2000, five onsite and one offsite groundwater remediation systems removed approximately 700 pounds (318 kg) of volatile organic compounds and returned approximately one billion gallons (3.8 billion liters) of treated water to the Upper Glacial aquifer.

Chapter 7

# Groundwater Protection

### 7.1 THE BNL GROUNDWATER PROTECTION MANAGEMENT PROGRAM

U.S. Department of Energy (DOE) Order 5400.1 (1988), *General Environmental Protection Program*, requires development and implementation of a groundwater protection program. The primary goal of the BNL Groundwater Protection Management Program is to ensure that plans for groundwater protection, management, monitoring, and restoration are fully defined, integrated, and managed in a cost-effective manner that is consistent with federal, state, and local regulations. This program is described in the *BNL Groundwater Protection Program Description* document (Paquette *et al.* 1998). The BNL Groundwater Protection Program consists of four interconnecting elements: (1) preventing pollution of the groundwater, (2) monitoring the effectiveness of engineered/administrative controls at operating facilities, and groundwater treatment systems, (3) restoration of the environment by cleaning up contaminated soil and groundwater, and (4) communicating with interested parties on groundwater protection issues (Figure 7-1). BNL's goal is to identify, track, and remediate, as necessary, existing contamination and ensure that new contamination does not occur.

**Figure 7-1. Elements of BNL's Groundwater Program.**

♦ *Prevention*

BNL has conducted a three-phased project to: (1) identify past or current activities with the potential to affect environmental quality, (2) conduct a Laboratory-wide review of all experiments and industrial-type operations to determine the potential impacts of those activities on the environment and to integrate pollution prevention/waste minimization, resource conservation, and compliance into planning, decision-making, and implementation, and (3) develop and implement an Environmental Management System. These activities are designed to prevent further pollution of the sole source aquifer underlying the BNL site, and are described in Chapter 2. In addition, as described in Chapter 3, efforts are being made to achieve or maintain compliance with regulatory requirements and to implement best management practices designed to protect groundwater. Examples include upgrading underground storage tanks, closing cesspools, 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).

♦ *Monitoring*

BNL has an extensive groundwater monitoring network designed to evaluate the impacts of groundwater contamination from historical and current operations and to track cleanup progress. Groundwater monitoring is a means of verifying that protection and restoration efforts are working. Groundwater monitoring is focused in two general areas: (1) Environmental Surveillance (ES) 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 any duplication of effort in the installation, monitoring, and abandonment of wells. Furthermore, data quality objectives, plans and procedures, sampling and analysis, quality assurance, data management, and well installation, maintenance and abandonment programs have been integrated to (1) create a cost-effective monitoring system and (2) to ensure that water quality data are available for review and interpretation in a timely manner.

♦ *Restoration*

BNL was added to the National Priorities List in 1989 (see Chapter 2 for a discussion of the BNL's ER Program). To help manage the restoration effort, thirty separate Areas of Concern (AOC) were grouped into six Operable Units (OU) (see Figure 2-13). Remedial Investigation/Feasibility Studies have been conducted for each OU, and focus is now shifting to design and implementation of cleanup systems. Contaminant sources (e.g., contaminated soil, underground tanks) are being removed or remediated to prevent further contamination of groundwater. All remediation work is carried out under the Interagency Agreement (IAG) among the U.S. Environmental Protection Agency (EPA), New York State Department of Environmental Conservation (NYSDEC), and DOE.

♦ *Communication*

BNL has a community involvement, government and public affairs program to ensure that BNL communicates with the community in a consistent, timely and accurate manner. A number of communication mechanisms are in place, such as web pages, mailings, public meetings, briefings, and roundtable discussions. Specific examples include the Community Advisory Council and the Brookhaven Executive Roundtable. In addition, BNL has developed a *Groundwater Protection Contingency Plan* (BNL 2000) that provides a formal process to communicate off normal or unusual monitoring results to BNL's management, DOE, regulatory agencies, and other stakeholders in a timely manner.

### 7.2 GROUNDWATER PROTECTION PERFORMANCE

Since 1998 the BNL Groundwater Protection Management Program has been tracking progress towards eliminating new contamination of the aquifer system. While the Laboratory has made significant investments in environmental and groundwater protection since 1998, it has not yet eliminated all new groundwater impacts. BNL is currently in a transition period, and it is expected to take several more years before the recent investments in environmental and groundwater protection allow BNL to reach its "zero" groundwater impact goal. A new groundwater impact is defined as the detection of unusual or off normal groundwater monitoring results. During 1999-2000, BNL developed a *Groundwater Protection Contingency Plan* (BNL 2000) that 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, stakeholder notifications, and implementing appropriate corrective actions.

From 1998 through 2000, BNL installed hundreds of new permanent and temporary monitoring wells as a result of a comprehensive evaluation of known or potential contaminant source areas. During this period, BNL has identified nine new groundwater impacts using this enhanced monitoring system (Figure 7-2). It is important to note, however, that four of these were determined to be from historical (or legacy) contaminant releases. These legacy issues include the discovery of low level petroleum hydrocarbon contamination in groundwater near the BNL Service Station, the discovery of tritium near the former U-Line target area at the AGS, the discovery of 1,1,1-trichloroethane (TCA) near Building 830 and the BNL Motor Pool. In addition, the improved groundwater surveillance program detected three small tritium plumes that originated from active experimental areas at the AGS (the g-2 and E-20 Catcher areas) and the BLIP facility. In two cases, activities associated with the Laboratory's environmental restoration program resulted in new groundwater impacts. One was the inadvertent release of carbon tetrachloride during the removal of an underground storage tank, and the second was caused by an unex-

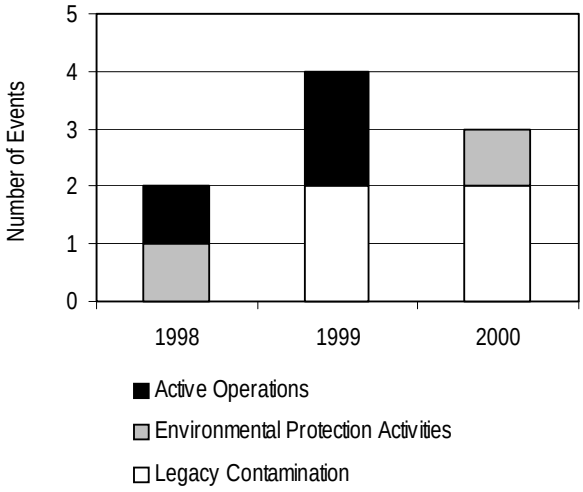


**Figure 7-2. Groundwater Impact Events (1998-2000).**

**Figure 7-3. Sampling a Groundwater Monitoring Well.**

pected displacement of tritium during an innovative grout injection process designed to protect groundwater quality by stabilizing activated soils at the BLIP facility. In all nine cases, BNL thoroughly investigated the cause of the contamination and took corrective actions as necessary to eliminate or limit the scale of these impacts.

BNL will continue the efforts to prevent new groundwater impacts, and is vigilant in measuring performance and improving upon environmental and efforts.

### 7.3 GROUNDWATER MONITORING

Groundwater monitoring program elements include installing monitoring wells, planning and scheduling, quality assurance, sample collection (see Figure 7-3), sample analysis, data verification, validation and interpretation, and reporting. Monitoring wells are generally used to evaluate BNL's progress in restoring groundwater quality, to comply with regulatory permit requirements, monitor active research and support facilities, assess the quality of groundwater entering or leaving the BNL site, and ensure that corrective measures designed to protect and restore groundwater are, in fact, working.

The groundwater beneath the BNL site is classified by New York State as Class GA groundwater. Class GA groundwater is defined as a source of potable water supply and suitable for drinking. As such, federal drinking water standards, New York State Drinking Water Standards (NYS DWS), and New York State Ambient Water Quality Standards (NYS AWQS) for Class GA groundwater are used as groundwater protection and remediation goals. The BNL groundwater surveillance program uses monitoring wells (which are not utilized for drinking water supply) to monitor research and support facilities where there is a potential for environmental impact, and areas where past waste handling practices or accidental spills have already degraded groundwater quality. BNL evaluates the potential impact of radiological and nonradiological levels of contamination by comparing analytical results to New York State and DOE reference levels and background water quality levels. Nonradiological analytical results from groundwater samples collected from surveillance wells are usually compared to NYS AWQS. Radiological data are compared to NYS DWS (for tritium, gross beta, and strontium-90), NYS AWQS (for gross alpha and radium-226/228), and Safe Drinking Water Act (SDWA)/DOE Derived Concentration Guides (for determining the 4 mrem dose for other beta/gamma-emitting radionuclides). 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 the timely investigation into the identification and remediation of the source.

Groundwater quality at BNL is routinely monitored through a network of approximately 680 onsite and offsite surveillance wells (see Figure 7-4). In addition to groundwater quality assessments, water levels are routinely measured in over 650 onsite and offsite wells to assess variations in directions and velocities of groundwater flow. Groundwater flow directions in the vicinity of BNL are shown on Figure 7-5.

Active and inactive facilities that have groundwater monitoring programs include the Sewage Treatment Plant/Peconic River area, Biology Agricultural Fields, Former Hazardous Waste Management Facility (HWMF), new Waste Management Facility (WMF), two former landfill areas, Central Steam Facility/Major Petroleum Facility (CSF/MPF), Alternating Gradient Synchrotron (AGS), Waste Concentration Facility (WCF), Supply and Materiel, and several other smaller facilities. As the result of detailed groundwater investigations conducted over the past fifteen years, six significant VOC plumes and eight radionuclide plumes have been identified (Figures 7-6 and 7-7).

## 7.4 SUPPLEMENTAL MONITORING PROGRAM FOR POTABLE AND PROCESS SUPPLY WELLS

As discussed in Chapter 3, BNL is a public water purveyor and maintains six potable water supply wells and associated treatment facilities for the distribution of potable water on the site. The quality of the BNL potable water supply is monitored as required by the Safe Drinking Water Act, and the analytical results are reported to the Suffolk County Department of Health Services. Groundwater quality is also routinely monitored at all active process supply wells. All supply wells are screened within the Upper Glacial aquifer. Because of the proximity of BNL's potable supply wells to known or suspected groundwater contamination plumes and source areas, BNL conducts a supplemental potable supply well monitoring program. The BNL supply well network consists of six potable water supply wells (Wells 4, 6, 7, 10, 11, and 12) and two secondary cooling/process water supply wells (Wells 9 and 105) (Figure 7-5). In 2000, Well 9 supplied process water to a facility where biological research on fish is conducted. Secondary cooling water for the Brookhaven Medical Research Reactor was supplied from Well 105.

Monitoring of the potable and process supply wells in 2000 included VOCs, inorganics (anions and metals), and radiological parameters. During 2000, the BNL potable water system fully complied with all drinking water requirements. Furthermore, as required by 1996 amendments to the Safe Drinking Water Act, BNL prepared a *Source Water Assessment for Drinking Water Supply Wells* (Bennett *et al*. 2000). The source water assessment is designed to serve as a management tool in further protecting the sole source aquifer system underlying the BNL site.

### 7.4.1 RADIOLOGICAL RESULTS

Potable well water was sampled and analyzed for gross alpha and gross beta activity, tritium, and strontium-90; the results are listed in Table 7-1. In addition, tap water samples were collected daily from Building 490 (Analytical Services Laboratory) and analyzed for gross alpha and beta activity and tritium. Nuclide-specific gamma spectroscopy was also performed for potable well samples, supplementing the requirements of the SDWA which does not require this analysis unless gross beta activity exceeds 50 pCi/L (1.8 Bq/L). Average gross activity and tritium levels in the potable water wells were consistent with those of typical background water samples. Neither strontium-90 nor any man-made gamma-emitting radionuclides were observed above the minimum detection limit (MDL) in any of the potable water samples.

### 7.4.2 NONRADIOLOGICAL RESULTS

#### 7.4.2.1 VOLATILE ORGANIC COMPOUNDS (VOCS)

Samples collected from supply Wells 4, 6, 9, and 105 were analyzed for VOCs following EPA Standard Method 624. This method tests for 38 organic compounds, including halogenated and aromatic hydrocarbons. The only parameters detected above the MDL were chloroform and 1,1,1-trichloroethane (TCA). TCA was detected in Well 9 at 2.5 micrograms per liter (µg/L). Well 9 is located within a known area of contamination and is included

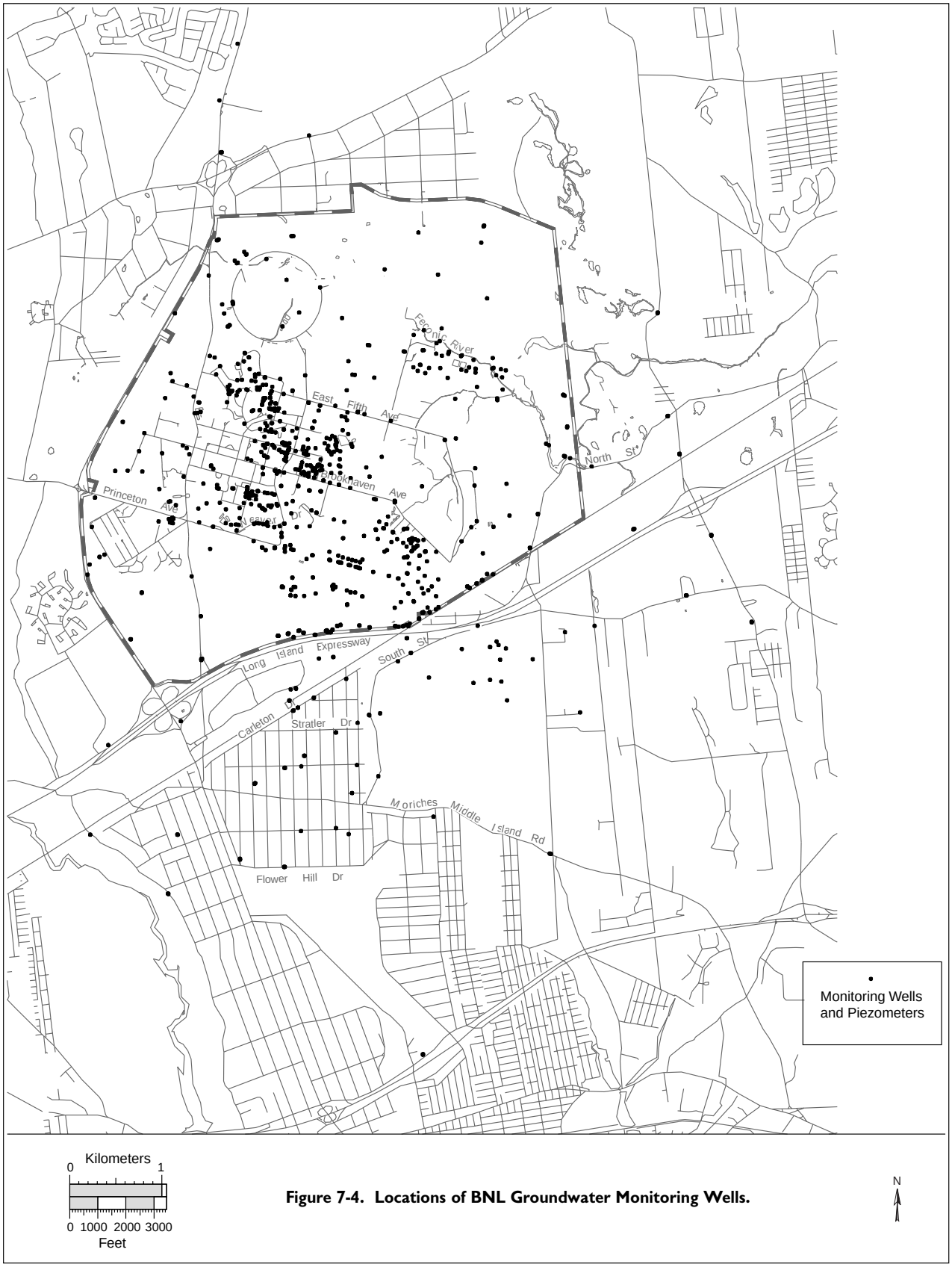


**Figure 7-4. Locations of BNL Groundwater Monitoring Wells.**

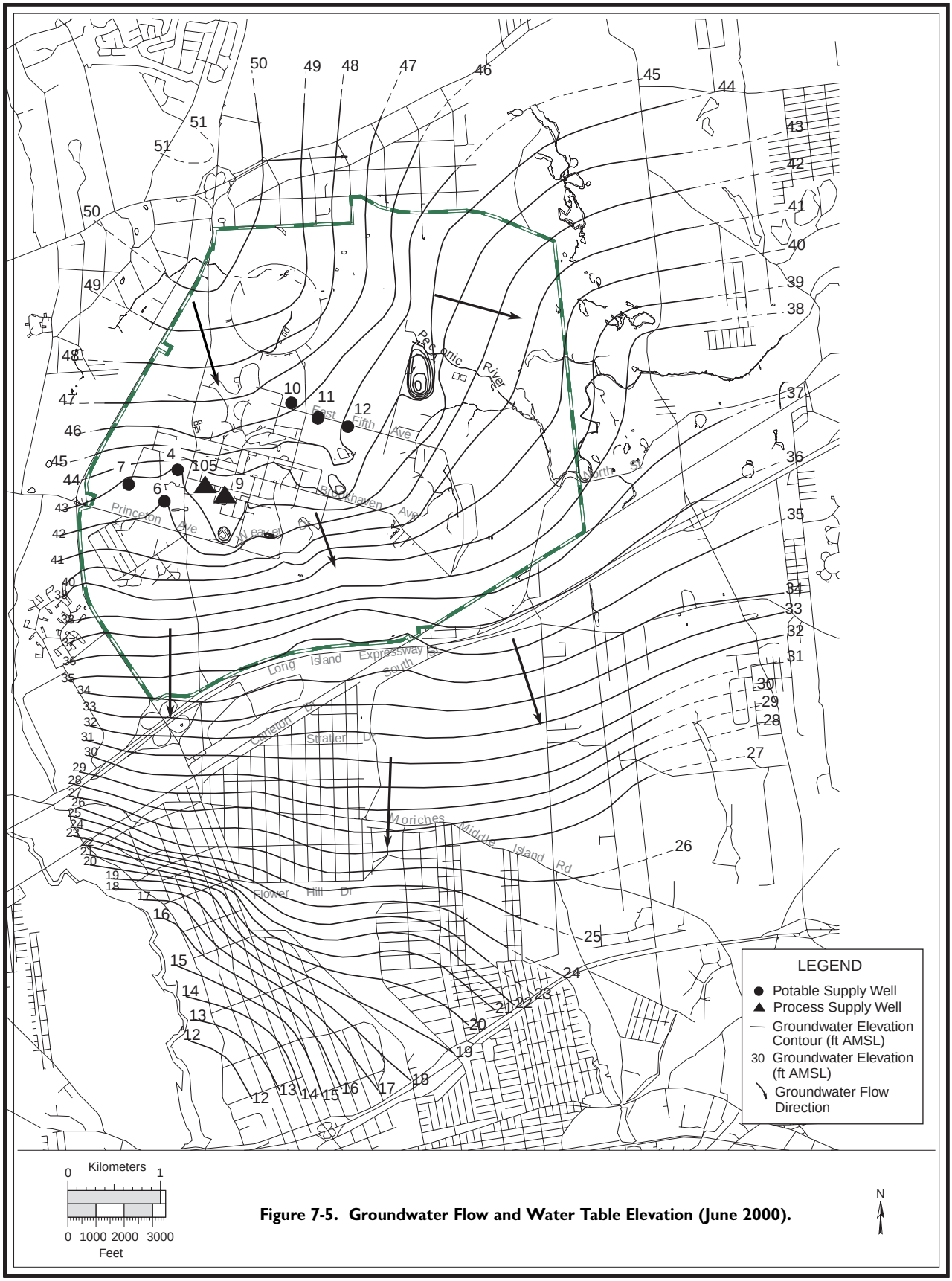


**Figure 7-5. Groundwater Flow and Water Table Elevation (June 2000).**

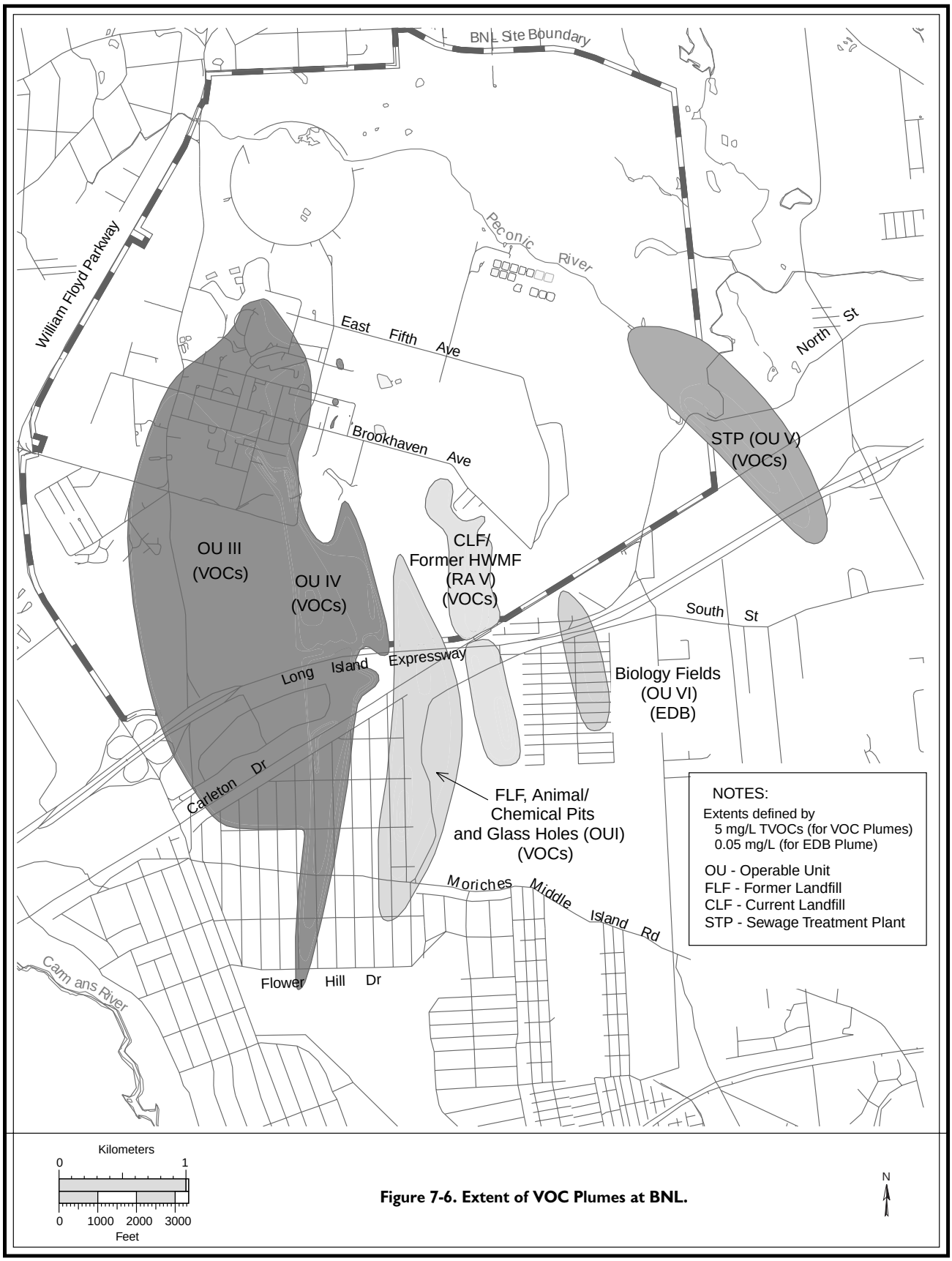


**Figure 7-6. Extent of VOC Plumes at BNL.**

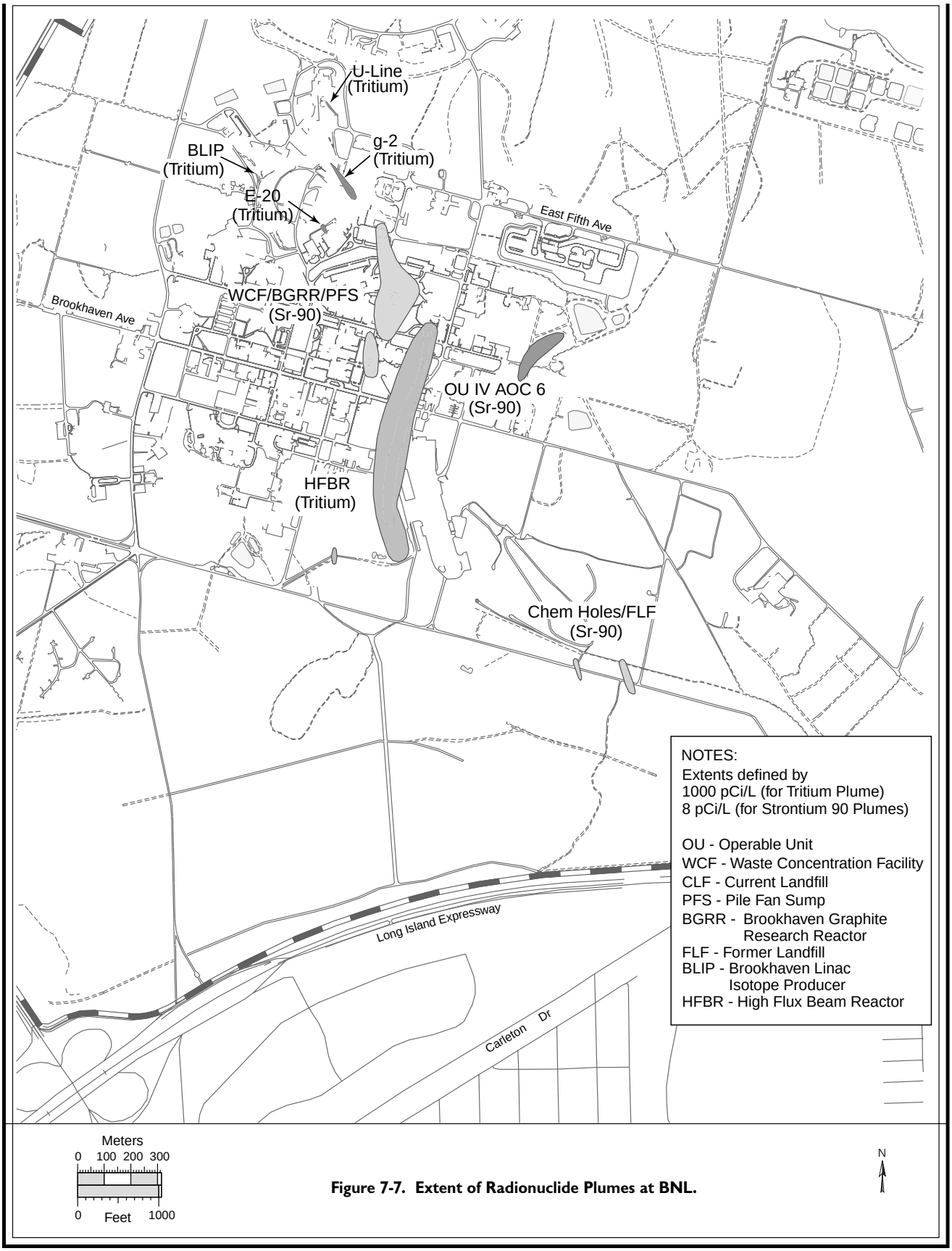


**Figure 7-7. Extent of Radionuclide Plumes at BNL.**

**Table 7-1. Potable Water Supply Radiological Analytical Results (CY 2000).**

| Potable Well ID[a] | | Gross Alpha (pCi/L) | Gross Beta (pCi/L) | Tritium (pCi/L) | Sr-90 (pCi/L) |
|---|---|---|---|---|---|
| 4 (FD) | N | 4 | 4 | 4 | 3 |
| | Max. | 1.1 ± 0.6 | 13.1 ± 1.6 | < 320 | < 0.55 |
| | Avg. | 0.8 ± 0.3 | 4.5 ± 5.2 | -36 ± 123 | -0.1092 ± 0.09 |
| 6 (FF) | N | 5 | 5 | 5 | 2 |
| | Max. | 1.3 ± 0.8 | 6.1 ± 1.4 | < 315 ± < 0.58 | |
| | Avg. | 0.7 ± 0.3 | 3.8 ± 1.4 | -5 ± 70 | 0.25 ± 0.29 |
| 7 (FG) | N | 6 | 6 | 6 | 2 |
| | Max. | < 0.7 | 3.5 ± 1.4 | < 289 | < 0.68 |
| | Avg. | 0.1 ± 0.2 | 2.1 ± 1.1 | 26 ± 77 | 0.38 ± 0.285 |
| 10 (FO) | N | 3.0 | 3 | 3 | 1 |
| | Max. | 1.0 ± 0.6 | 2.8 ± 1.32 | < 304 | < 0.41 |
| | Avg. | -0.1 ± 0.8 | 1.7 ± 0.8 | -26 ± 23 | NA |
| 11 (FP) | N | 6 | 6 | 6 | 2 |
| | Max. | < 0.8 | 5.2 ± 1.4 | < 304 | < 0.70 |
| | Avg. | 0.1 ± 0.3 | 2.6 ± 1.3 | 73 ± 90 | 0.28 ± 0.38 |
| 12 (FQ) | N | 5 | 5 | 5 | 2 |
| | Max. | < 0.8 | 5.2 ± 1.4 | < 315 | < 0.61 |
| | Avg. | -0.0 ± 0.5 | 3.1 ± 1.0 | 55 ± 110 | -0.08 ± 0.01 |
| Tap Water[b] | N | 247 | 247 | 248 | NS |
| Bldg. 490 | Max. | 7.7 ± 3.0 | 16.6 ± 6.1 | 307 ± 189 | |
| (FN) | Avg. | 2.5 ± 0.2 | 5.0 ± 0.4 | -30 ± 14 | |
| **SDWA Limit** | | 15[c] | 50[d] | 20,000 | 8 |

Notes:
See Figure 7-5 for well locations.
All values shown with 95% confidence interval.
No anthropogenic gamma-emitting radionuclides were detected in samples collected from these wells in 2000.
N=Number of samples collected
NS=Not sampled for this analyte
NA=Not applicable to one value
SDWA=Safe Drinking Water Act
[a]Historic ID shown in parentheses.
[b]The gross activity values for FN are elevated compared with the other potable wells due to differences in the analytical procedure (smaller sample volumes and shorter counting times) used to obtain the activity values.
[c]Excluding radon and uranium.
[d]Screening level above which analysis for individual radionuclides is required.

in the Operable Unit III study area. At these concentrations, the TCA does not interfere with the fish experiments for which the water is used.

Chloroform was found in most wells, with concentrations ranging from trace levels (< 2 µg/L) to a maximum of 4.2 µg/L. All chloroform concentrations were equal to or below the ambient water quality standard of 7 µg/L and well below the drinking water standard of 80 µg/L.

#### 7.4.2.2 METALS AND ANIONS

Samples collected at Supply Wells 4, 6, 7, 10, and 11 were analyzed for metals and anions. The results are summarized in Tables 7-2 (anions) and 7-3 (metals). Review of these data shows that the water obtained from Wells 10 and 11 fully comply with drinking water requirements. Iron is present in Wells 4, 6, and 7. Water collected from these wells is treated for iron removal at the Water Treatment Plant prior to site distribution.

### 7.5 ENVIRONMENTAL SURVEILLANCE PROGRAM (NON-CERCLA)

BNL's Environmental Surveillance Program includes groundwater monitoring at active research facilities (e.g., research reactor areas, accelerator beam stop and target areas, greenhouse areas) and support facilities (e.g., fuel storage facilities and water treatment facilities).

In September 1998, BNL finalized a *Groundwater Monitoring Improvements Plan* (Paquette 1998) that identified active research and support facilities requiring improved groundwater monitoring programs. As a result of this evaluation, 84 new, permanent groundwater monitoring wells were installed on a prioritized basis during 1999 and 2000. During 2000, 120 groundwater surveillance wells were monitored during 350 individual sampling events. All wells sampled during 2000 are listed in Appendix E. Results for these programs are summarized below. For detailed descriptions and maps related to groundwater monitoring in the Environmental Surveillance Monitoring Program, refer to the *BNL CY 2000 Groundwater Status Report* (BNL 2001).

### 7.5.1 SURVEILLANCE MONITORING OF RESEARCH FACILITIES

#### 7.5.1.1 ALTERNATING GRADIENT SYNCHROTRON (AGS) COMPLEX

Activated soils have been created near a number of AGS experimental areas as the result of secondary particles (primarily neutrons) produced at beam targets and beam stops. Radionuclides, such as tritium and sodium-22, have been produced by the interaction of these secondary particles with the soils that surround the experimental areas. Furthermore, historical surface spills and discharges of solvents to cesspools and recharge basins near the AGS have contaminated soils and groundwater with VOCs. VOC contamination is monitored under the ER Program's OU III Central Areas Project (see Section 7.6.3).

During 2000, 41 groundwater monitoring wells were used to evaluate groundwater quality near potential soil activation areas within the AGS Complex (e.g., Building 912, AGS Booster Beam Stop, 914 Transfer Tunnel, g-2 experimental area, E-20 Catcher, former U-Line Target, and the new J-10 Beam Stop). Thirty-nine of these wells were installed as part of the Groundwater Monitoring Improvements project during 1999 and 2000. Since 1999, the enhanced groundwater monitoring program detected three tritium plumes that are associated with activated soil shielding.

These plumes originated from the g-2 experimental area, former U-Line area, and the Former E-20 Catcher region of the AGS Complex (see Figure 7-8).

**Table 7-2. Potable Water Supply Wells Water Quality Data (CY 2000).**

| Potable Well ID.* | | Chlorides | Sulfates | Nitrate as N |
|---|---|---|---|---|
| | | mg/L | | |
| | N | 1 | 1 | 1 |
| 4 (FD) | Value | 14.8 | 10 | < 1 |
| | N | 1 | 1 | 1 |
| 6 (FF) | Value | 14.2 | 10 | < 1 |
| | N | 1 | 1 | 1 |
| 7 (FG) | Value | 20.2 | 11.6 | < 1 |
| | N | 1 | 1 | 1 |
| 10 (FO) | Value | 11.6 | 9.6 | < 1 |
| | N | 1 | 1 | 1 |
| 11 (FP) | Value | 22.5 | 12.9 | < 1 |
| **NYS DWS** | | 250 | 250 | 10 |
| **Typical MDL** | | 4 | 4 | 1 |

Notes:
See Figure 7-5 for location of wells.
*Historic ID shown in parentheses.
N = Number of Samples
NYSDWS = New York State Drinking Water Standard
MDL = Minimum Detection Limit

##### 7.5.1.1.1 g-2 EXPERIMENT AREA

In November 1999, monitoring wells located approximately 250 feet (76 m) downgradient of the g-2 experimental area detected the presence of tritium and sodium-22 in groundwater. A sample from Well 054-67 collected in October 1999 had a tritium concentration of 41,700 pCi/L (1,543 Bq/L). (Note: The drinking water standard for tritium is 20,000 pCi/L or 740 Bq/L.) A groundwater investigation conducted during November-December 1999 revealed a narrow tritium plume of approximately 20-30 feet (6-9m) wide and 250-300 feet (76-91 m) long. The maximum radionuclide concentrations were detected in temporary Well 054-116, located approximately 70 feet (21 m) downgradient of the g-2 beam line, with a tritium concentration of 1,800,000 pCi/L (66,600 Bq/L) and sodium-22 concentration of 60 pCi/L (2.2 Bq/L). (Note: The drinking water standard for sodium-22 is 400 pCi/L or 14.8 Bq/L.) Following the discovery, an investigation into the source of the contamination revealed that the tritium originated from activated soil shielding located adjacent to the g-2 experiment's VQ-12 Magnet. In December 1999, an impermeable (Gunite™) cap was installed over the soil activation area to

**Table 7-3. Total Metals Concentration Data for Potable Water Supply Well Samples (CY 2000).**

| Potable Well ID.* | 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 | Mo µg/L | Ni µg/L | Na µg/L | Pb µg/L | Sb µg/L | Se µg/L | Tl µg/L | V µg/L | Zn µg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 (FD) | 1 | 7.7 | 7.9 | < 3 | 23.8 | < 0.7 | < 1.1 | 0.7 | 1.1 | 45.1 | 2.2 | < 0.2 | 0.2 | < 5.0 | < 1.1 | 10.2 | < 1.3 | < 0.9 | 12 | < 0.7 | < 5.5 | < 4 |
| 6 (FF) | 1 | < 1 | 12.4 | 3.4 | 22.2 | < 0.7 | < 1.1 | 0.7 | 2 | 15.1 | 4 | < 0.2 | 0.08 | < 5.0 | 3.8 | 9.1 | < 1.3 | < 0.9 | 12 | < 0.7 | < 5.5 | 10.7 |
| 7 (FG) | 1 | < 1.0 | 6.6 | 3.6 | 24.8 | < 0.7 | < 1.1 | 0.6 | 1.1 | 3.7 | 1.7 | < 0.2 | 0.07 | < 5.0 | 1.2 | 13.1 | < 1.3 | < 0.9 | 12 | < 0.7 | < 5.5 | 20.7 |
| 10 (FO) | 1 | < 1.0 | 4.1 | < 3.0 | 13.5 | < 0.7 | < 1.1 | < 0.1 | 1.1 | 18.1 | 0.1 | < 0.2 | 0.01 | < 5.0 | < 1.1 | 9.6 | < 1.3 | < 0.9 | 12 | < 0.7 | < 5.5 | 16 |
| 11(FP) | 1 | < 1.0 | 4.1 | < 3.0 | 32.9 | < 0.7 | < 1.1 | < 0.1 | 1.2 | 7.1 | < 0.0 | < 0.2 | < 0.00 | < 5.0 | < 1.1 | 15.5 | < 1.3 | < 0.9 | 12 | < 0.7 | < 5.5 | 28 |
| **NYS DWS** | | 100 | SNS | 6 | 2000 | 4 | 5 | SNS | 100 | 1300 | 0.3 | 2 | 0.3 | SNS | 100 | SNS | 15 | 6 | 50 | 2 | SNS | 5000 |
| **Typical MDL** | | 1 | 2.2 | 3 | 1.8 | 0.7 | 1.1 | 0.1 | 1 | 2 | 0.075 | 0.2 | 2 | 5 | 1.1 | 1 | 1.3 | 0.9 | 5 | 0.7 | 5.5 | 4 |

Notes:
See Figure 7-5 for well locations.
*Historic ID shown in parentheses.
NYSDWS = New York State Drinking Water Standard
MDL = Minimum Detection Limit
SNS = Drinking Water Standard Not Specified.

prevent rainwater infiltration and the continued leaching of the radionuclides out of the soils and into groundwater. In September 2000, the activated soil shielding and the associated tritium plume were designated as sub-Area of Concern 16T. Following this designation, DOE agreed to prepare an Engineering Evaluation/Cost Analysis (EE/CA) to evaluate the adequacy of the corrective actions taken to date, and the need for further actions. During 2000, eight permanent monitoring wells in the g-2 area were sampled on a quarterly basis. Samples were collected for tritium analysis and gamma spectroscopy. Due to a significant reduction in pumpage from potable supply Well 10 in early 2000, groundwater flow directions in the eastern section of the AGS facility changed from east-southeast to a more southeasterly direction. As a result, the tritium plume shifted slightly away from most of the established monitoring well network. As the flow direction of the plume shifted to the southeast, tritium concentrations in Well 054-07 increased from approximately 3,300 pCi/L (122 Bq/L) in November 1999 to 293,000 pCi/L (10,841 Bq/L) in July 2000. By October 2000, tritium concentrations in Well 054-07 decreased to 74,000 pCi/L (2,738 Bq/L). Time of travel from the VQ-12 source area to Well 054-07 is approximately six to seven months. The decrease in tritium concentration in Well 054-07 is probably an indication that the Gunite™ cap that was installed in December 1999 has been effective in preventing rainwater infiltration through the activated soils. Alternatively, the concentration fluctuations observed in Well 054-07 could be due to the well being located on the margin of a more concentrated tritium plume. In early 2001, a series of temporary wells will be installed as part of the g-2 EE/CA to verify the position of the plume in this area and evaluate the effectiveness of the cap.

Based upon available monitoring well data and groundwater flow direction and rates, it is likely that the leading edge of the plume is now located east of Building 912 (Figure 7-8). Shallow Wells 065-123, 065-124 and 065-125 were originally installed to monitor soil activation areas located below the Building 912 floor. For the first three quarters of 2000, tritium concentrations in

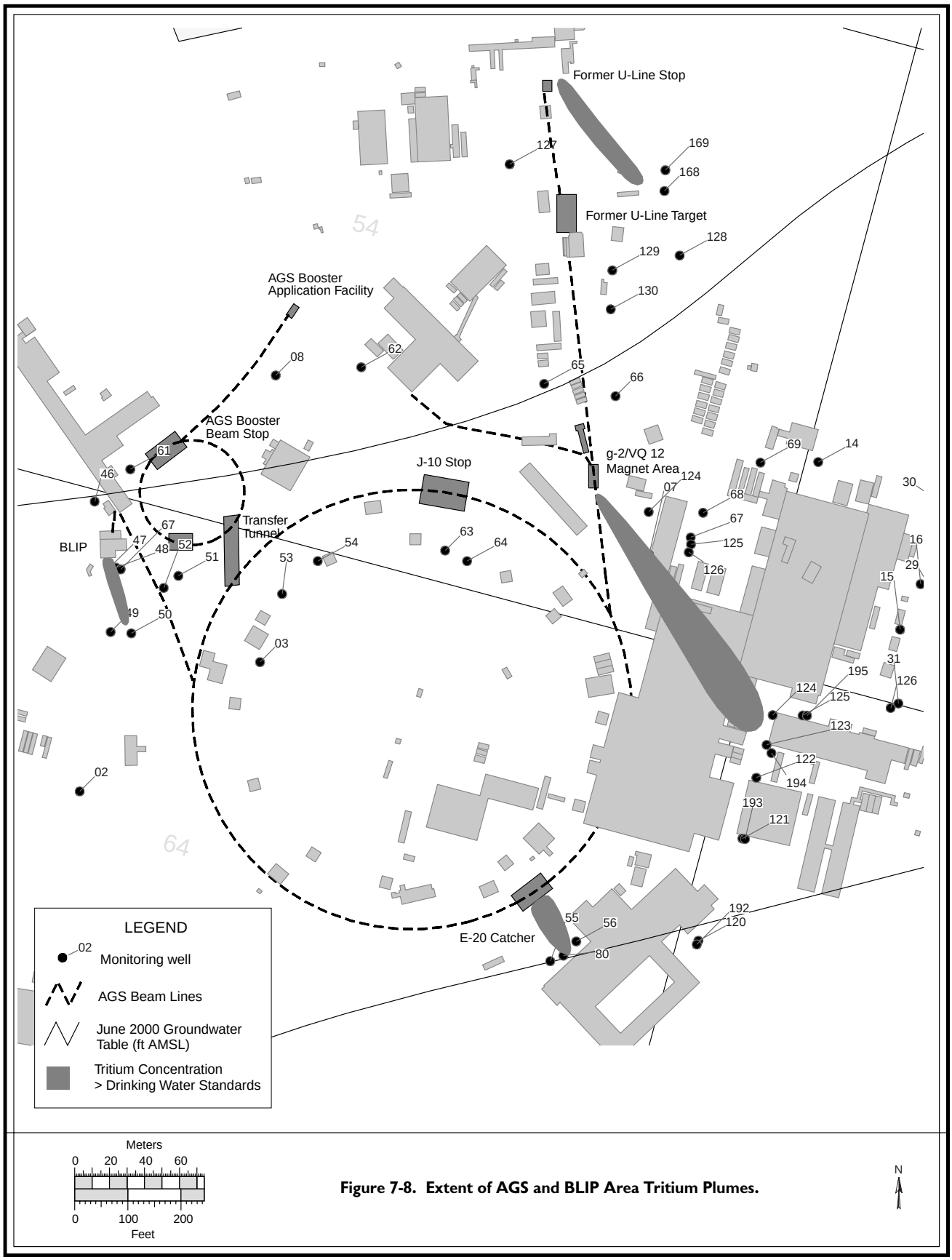


**Figure 7-8. Extent of AGS and BLIP Area Tritium Plumes.**

these wells ranged between nondetectable (i.e., below the typical MDL of approximately 350 pCi/L or 13 Bq/L) to 528 pCi/L (20 Bq/L). Sodium-22 was also detected at concentrations up to 18 pCi/L (0.67 Bq/L). Significant increases in tritium concentrations were observed in samples collected in October 2000, with a maximum tritium concentration of 3,690 pCi/L (136 Bq/L) observed in Well 065-124. This increase may be an indication that the leading edge of the g-2 tritium plume has emerged from beneath Building 912. This is a reasonable interpretation considering distance from the source (approximately 600 feet [183m]) and an average groundwater flow rate of approximately 0.6 feet per day. During the g-2 EE/CA, temporary Geoprobe™ wells will be used to verify the vertical distribution of tritium in areas east of Building 912.

#### 7.5.1.1.2 FORMER E-20 CATCHER AREA

In late 1999, tritium and sodium-22 were detected in wells located approximately 100 feet (30 m) downgradient of the former E-20 Catcher (Figure 7-8). The highest levels of tritium and sodium-22 were detected in Well 064-56 at concentrations of 5,800 pCi/L (215 Bq/L) and 219 pCi/L (8 Bq/L), respectively. To further evaluate the extent of contamination, four temporary wells were installed in January 2000. The highest levels of tritium and sodium-22 were found in Geoprobe™ Well 064-065 with concentrations of 40,400 pCi/L (1,495 Bq/L) and 704 pCi/L (26 Bq/L), respectively. This well was installed approximately 12 feet southwest of permanent Well 064-56. These data indicate that at a distance of approximately 100 feet (30.5 meters) downgradient of the E-20 Catcher, the zone of elevated tritium and sodium-22 is estimated to be approximately 20 to 30 feet wide (9.15 meters) and situated within 10 feet (3 m) of the water table (approximately 30 to 40 feet [9-12 m] below land surface). In April 2000, a temporary impermeable cap was installed over the E-20 Catcher soil activation area to prevent rainwater infiltration and the continued leaching of the radionuclides out of the soils and into groundwater. A permanent (geomembrane) cap was constructed by October 2000, and one additional well (Well 064-80) was installed for improved long-term monitoring of the source area.

#### 7.5.1.1.3 FORMER U-LINE TARGET AND STOP AREAS

Low levels of tritium and sodium-22 have been frequently detected in wells located downgradient of the former U-Line target (Figure 7-8). The tritium and sodium-22 concentrations are well below the applicable drinking water standards. The highest tritium concentration was 6,110 pCi/L (226 Bq/L) detected in Well 055-14 which is located approximately 500 feet (152 m) downgradient of the former U-Line target. The highest sodium-22 concentration was 20.9 pCi/L (0.8 Bq/L) in Well 054-129 located approximately 200 feet (61 m) downgradient of the target area. Low-level contamination from the former U-Line area can be traced to Well 055-29, located approximately 1,000 feet (305 m) downgradient of the target area. The maximum tritium and sodium-22 concentrations detected in this well were 4,710 pCi/L (174 Bq/L) and 15.2 pCi/L (0.6 Bq/L), respectively.

In March and April 2000, four temporary wells were installed approximately 200 feet (61 m) downgradient of the former U-Line beam stop (Figure 7-8). The highest tritium concentrations were detected in temporary Well 054-133, with a tritium concentration of 71,600 pCi/L (2,649 Bq/L) at a depth of 35-39 feet (11-12 m) below land surface (approximately 12 to 16 feet [4-5 m] below the water table). Sodium-22 was not detected in any of the samples collected from the four temporary wells. The tritium plume (as defined by concentrations greater than 20,000 pCi/L) appears to be very narrow — only 20 to 25 feet wide. In May 2000, a temporary impermeable cap was installed over the U-Line beam stop soil activation area to prevent rainwater infiltration and leaching of the radionuclides out of the soils and into groundwater. By October 2000, a permanent (geomembrane) cap was constructed over the former beam stop area, and two additional permanent wells (054-168 and 054-169) were installed to provide long-term monitoring.

### 7.5.1.2 BROOKHAVEN LINAC ISOTOPE PRODUCER (BLIP)

The BLIP facility is located at the southern end of the Linear Accelerator (Figure 7-8). When the BLIP is operating, the Linear Accelerator delivers a beam of protons that impinges on a series of eight targets located within the BLIP target vessel. During irradiation, activation of the soils immediately

outside of the vessel occurs due to the creation of secondary particles produced at the target. In February 1998, elevated levels of tritium and sodium-22 were detected in wells located downgradient of BLIP. The subsequent installation of temporary wells approximately 40 feet (12.1 m) downgradient of the BLIP target detected tritium and sodium-22 concentrations of 52,000 pCi/L (1,924 Bq/L) and 151 pCi/L (5.6 Bq/L), respectively. To prevent rainwater from infiltrating the activated soils below the building, the BLIP building's roof drains were redirected away from the building, paved areas were resealed, and an extensive Gunite™ (cement) cap was installed on three sides of the building. In June 2000, BNL took an additional protective measure by using an innovative silica grouting technique to reduce the permeability of the activated soils.

Groundwater monitoring data collected from January 1999 to July 2000 indicated that the corrective actions taken during 1998 (i.e., Gunite™ cap, sealed pavement and rerouted roof gutters) were highly effective in preventing the release of tritium and sodium-22 from the activated soils surrounding the BLIP target vessel. Tritium and sodium-22 were not detected in samples collected in April 2000. However, significant increases in tritium and sodium-22 concentrations were observed in groundwater samples collected soon after the activated soils were treated with the silica grout injection process. Groundwater samples collected in early July indicated tritium and sodium-22 concentrations of 5,700 pCi/L (210 Bq/L) and 57 pCi/L (2 Bq/L), respectively. Samples collected in early October 2000 indicated tritium concentrations that exceeded the drinking water standard of 20,000 pCi/L (740 Bq/L). The maximum tritium concentration was 56,500 pCi/L (2,090 Bq/L) in samples from monitoring well 064-67, located approximately 40 feet (12 m) downgradient of the BLIP vessel. In accordance with the *BNL Groundwater Protection Contingency Plan*, BNL and DOE notified the regulatory agencies of this situation and increased the sampling frequency for the wells. The maximum sodium-22 concentration was 299 pCi/L (11 Bq/L) detected in Well 064-67 on December 1, 2000. By December 21, 2000, tritium concentrations dropped to below the 20,000 pCi/L (740 Bq/L) drinking water standard in wells located approximately 40 feet (12 m) downgradient of BLIP. Concurrently, as the slug of tritium continued to migrate downgradient of the BLIP, concentrations in Well 064-50 increased to 20,000 pCi/L (740 Bq/L) by December 28, 2000. Well 064-50 is located approximately 150 feet (46 m) downgradient of BLIP.

Following the detection of elevated tritium concentrations in October 2000, BNL, DOE, and external experts conducted a review of the grouting process. Findings of this review suggest that grout displaced residual vadose-zone soil pore water that was contaminated with tritium. The pattern of decreasing tritium concentrations in wells directly downgradient of BLIP indicated a short-term (pulsed) tritium release and that the plume has dissipated quickly in the aquifer. Although the grouting process had a short-term impact on groundwater quality, it is believed that the process will provide long-term benefits in reducing the permeability of the contaminated soil shielding. Information on the potential for displacing residual pore water will be used to improve this innovative grouting technology.

#### 7.5.1.3 RELATIVISTIC HEAVY ION COLLIDER (RHIC)

Within the RHIC facility, there are two areas where low levels of radionuclides could be produced in the soils outside of the collider tunnel. The first area contains two beam stops that are located at the 10 o'clock position of the ring, and the second contains two collimators that are located at the 8 o'clock region. Secondary particles created at the internal beam stop and collimator areas have the potential to activate the soils immediately surrounding those areas. During 1999, twelve wells were installed to provide a means of verifying that the engineered (i.e., impermeable caps) and operational controls designed into the RHIC beam stops and collimators are effective in protecting groundwater quality. Six monitoring wells were installed in the beam stop area and six wells were installed in the collimator area.

Groundwater samples were collected from the twelve RHIC monitoring wells on a semiannual schedule during 2000. Surface water samples were also collected from the Peconic River both upstream and downstream of the beam stop area. No tritium or

sodium-22 was detected in any of the groundwater or surface water samples.

#### 7.5.1.4 BROOKHAVEN MEDICAL RESEARCH REACTOR (BMRR)

During a 1997 evaluation of groundwater quality near the BMRR, low levels of tritium were detected in the groundwater downgradient of the reactor building. The maximum tritium concentration was 11,800 pCi/L (44 Bq/L) in wells installed directly downgradient (within 30 feet [9.15 m]) of the facility. Based upon inspection of the facility and review of historical records, the tritium is believed to have originated from the historical discharge of small amounts of BMRR primary cooling water to a basement floor drain and sump system that may have leaked. Although the last discharge of primary cooling water to the floor drain system occurred in 1987, the floor drains continued to be used for secondary (nonradioactive) cooling water until 1997. The infiltration of this water may have promoted the movement of residual tritium from the soils surrounding the floor drain piping system to the groundwater. The floor drains were permanently sealed in 1998 to prevent any accidental future releases to underlying soils.

Monitoring results for 2000 indicate that tritium concentrations continued to be below the drinking water standard of 20,000 pCi/L (740 Bq/L). Detectable levels of tritium were observed in all three downgradient wells, with the maximum value of 7,870 pCi/L (291 Bq/L) in Well 084-27. Slightly elevated gross beta concentrations (up to 38.6 pCi/L or 1.4 Bq/L) were detected in several samples from downgradient Well 084-13. As in past years, no other reactor-related radionuclides, including strontium-90, were detected during 2000. The elevated gross beta values are probably due to naturally occurring potassium-40, which was detected in BMRR groundwater samples at concentrations up to 105 pCi/L (3.9 Bq/L).

### 7.5.2 SURVEILLANCE MONITORING OF SUPPORT FACILITIES

#### 7.5.2.1 SEWAGE TREATMENT PLANT (STP) AREA

As described in Chapters 1 and 3, the STP processes sanitary sewage from BNL facilities. Approximately 15% of the treated effluent released to the STP's sand filter beds either evaporates or directly recharges to groundwater; the remaining water is discharged to the Peconic River.

The STP groundwater surveillance program is designed to evaluate whether current operations are impacting groundwater quality. During 2000, six wells were used to monitor groundwater quality in the filter bed area and three wells were monitored in the holding pond area. Groundwater quality impacts resulting from historical STP discharges are currently being monitored as part of the OU V monitoring program using wells that are located at the site boundary and offsite areas (see Section 7.6.5).

*Radionuclides*

Radioactivity levels in samples collected from the STP wells were generally typical of ambient (background) levels. Tritium was not detected in wells located in the immediate filter bed area. However, low levels of tritium were detected in Wells 039-88 (up to 2,500 pCi/L or 92 Bq/L) and 039-89 (up to 799 pCi/L or 29 Bq/L), which are located downgradient of the holding ponds. Because the ponds have not been used recently to hold tritiated wastewater and the wells are located downgradient of the filter bed area, it is likely that the tritium originated from past wastewater releases to the filter beds. An elevated gross alpha concentration of 94.7 pCi/L (3.5 Bq/L) was detected in the June 2000 sample from Well 039-88. This value exceeds the 15 pCi/L (0.6 Bq/L) drinking water standard. However, gross alpha was not detected in the sample collected from this same well in December. Historical gross alpha measurements in groundwater at the STP have generally been less than 3 pCi/L (<0.1 Bq/L), well below the 15 pCi/L (0.5 Bq/L) standard. It is likely that the elevated gross alpha concentration in the June sample is due to an erroneous measurement or sample cross contamination. If future STP groundwater samples indicate elevated gross alpha, BNL will conduct radionuclide-specific analyses to identify possible alpha emitting radionuclides.

*Volatile Organic Compounds, Metals, and Anions*

During 2000, all water quality and most metals concentrations in wells monitoring

the STP were below applicable New York State Ambient Water Quality Standards (NYS AWQS). Sodium was detected at concentrations slightly above the standard of 20 mg/L in three filter bed area wells. Wells 039-07, 039-08, and 039-86 had maximum sodium concentrations of 22.3 mg/L, 30 mg/L, and 29.2 mg/L, respectively. Nitrates were detected in most STP area wells; however, all samples were below the standard of 10 mg/L. The maximum concentration of 9.9 mg/L was detected in filter bed area monitoring Well 039-08. Volatile organic compounds were not detected in any of the monitoring well samples.

#### 7.5.2.2 WATER TREATMENT PLANT (WTP)

At the direction of the New York State Department of Environmental Conservation, five shallow Upper Glacial aquifer surveillance wells were installed at the WTP in 1993 to assess potential leaching of iron from the plant's recharge basin (Basin HX) into the groundwater. Naturally high levels of iron in the groundwater pumped for potable and process supply is removed at the WTP, and the precipitated iron is discharged to the recharge basin during filter back flushing operations.

*Metals and Anions*

The groundwater monitoring wells in the WTP recharge basin area were sampled in June 2000. Analytical results indicate that anions and metals (including iron) concentrations were below the applicable NYS AWQS and were consistent with established background levels for Long Island. Since the beginning of the groundwater monitoring program in 1992, iron has rarely been detected above the typical detection limit of 0.075 mg/L in groundwater near Basin HX, and has never exceeded the 0.3 mg/L water quality standard.

#### 7.5.2.3 MOTOR POOL

Building 423 serves as the site Motor Pool, where BNL's fleet vehicles are repaired and refueled. Gasoline is stored in two 8,000-gallon (32,280 liter) capacity underground storage tanks, and waste oil is stored in one 500-gallon (1,892 liter) capacity underground storage tank. Although the underground storage tanks and associated distribution lines meet Suffolk County Article 12 requirements for secondary containment, leak detection, and high level alarms, BNL initiated a groundwater monitoring program in 1996 as a means of verifying that groundwater quality is not being impacted by current operations. Following a 1998 discovery of a hydraulic oil spill in Building 423 and a 1996 discovery of a historical oil spill immediately south of the nearby Site Maintenance Facility Building 326, BNL entered into a spill response (stipulation) agreement with NYSDEC. As part of this agreement, BNL installed six new groundwater surveillance wells in early 1999. Monitoring of these wells confirmed that these spills had not impacted groundwater quality, and these sites were removed from the NYSDEC's Active Spills List in early 2000.

*Volatile and Semivolatile Organic Compounds*

Two wells (102-05 and 102-06) are used to monitor for potential contaminant releases from the underground storage tank (UST) area. Except for low levels of the gasoline additive methyl tertiary butyl ether (MTBE) (up to 5 µg/L), no other chemicals related to gasoline products (e.g., benzene, ethylbenzene, toluene, or xylenes) were detected in groundwater. (Note: A NYS AWQS has not been established for MTBE.) MTBE has been used as a gasoline additive since 1977, and has been detected at low levels in the Motor Pool wells since the monitoring program began in 1996. The presence of MTBE in groundwater downgradient of the UST and pump island area is likely due to small-scale spillage during gasoline dispensing operations. No semivolatile compounds were detected in the groundwater samples. The solvent TCA was detected in Well 102-06 at a concentration of 6.9 µg/L. The NYS AWQS for TCA is 5 µg/L. The TCA contamination is probably due to historical parts degreasing operations. Wells 102-05 and 102-06 were also tested for the presence of floating petroleum hydrocarbons. As in previous years, no floating petroleum product was observed.

Groundwater quality downgradient of Building 423 and Building 326 is monitored using four wells (102-10, 102-11, 102-12, and 102-13). The program is designed to periodically assess existing solvent contamination that resulted from historical vehicle maintenance operations, and to confirm that the current engineered and institutional controls

are effective in preventing additional contamination of the aquifer.

During CY 2000, TCA was detected in Wells 102-10, 102-11, 102-12, and 102-13 at concentrations ranging from 7.4 µg/L to 79 µg/L. 1,1-dichloroethane (DCA) was detected in Well 102-12 at concentrations up to 10.6 µg/L. The NYS AWQS for TCA and DCA is 5 µg/L. Consistent with 1999 monitoring results, no semivolatile compounds were detected in the groundwater samples.

#### 7.5.2.4 UPTON SERVICE STATION

Building 630 is a commercial automobile repair and gasoline station for the BNL site. Gasoline is stored in two 8,000-gallon (30,280 liter) capacity and one 6,000-gallon (22,710 liter) capacity underground storage tanks, and waste oil is stored in one, 500-gallon (1,892 liter) capacity underground storage tank. Although the storage tanks and associated distribution lines meet Suffolk County Article 12 requirements for secondary containment, leak detection, and high level alarms, BNL initiated a groundwater monitoring program in 1996 as a means of verifying that groundwater quality is not being impacted by current operations. This program was enhanced in early 2000, by the installation of three new monitoring wells.

*Volatile and Semivolatile Organic Compounds*

Prior to 1999, low levels (<20 µg/L) of carbon tetrachloride were detected in Service Station Well 085-17. Approximately one year after the April 1998 removal of a carbon tetrachloride tank located 200 feet (61 m) northeast of the Service Station, higher levels of carbon tetrachloride started to be detected in Service Station area wells. (Note: The carbon tetrachloride tank was associated with an experiment conducted in the 1950s and is not related to service station operations.) In 1999, carbon tetrachloride concentrations in Well 085-17 was 503 µg/L, and by January 2000 carbon tetrachloride concentrations reached 2,000 µg/L. By June 2000, carbon tetrachloride concentrations in Well 085-17 were 4,400 µg/L. The NYS AWQS for carbon tetrachloride is 5 µg/L. BNL started to remediate the carbon tetrachloride plume in October 1999. Following the detection of high levels of carbon tetrachloride in January 2000, the Service Station area wells were temporarily incorporated into the ER Program's carbon tetrachloride plume monitoring program and placed on a monthly sampling schedule (see Section 7.6.3).

Petroleum hydrocarbon-related compounds were detected in two of the new wells (085-236 and 085-237) installed in January 2000 directly downgradient of the Service Station. These compounds were not detected in upgradient wells. Therefore, the source of the contamination is located close to or beneath the Service Station. No floating petroleum product was detected in the monitoring wells.

Primary petroleum hydrocarbon related compounds detected in samples collected from Wells 085-236 and 085-237 during January-May 2000 included: xylenes (up to 420 µg/L), ethylbenzene (up to 77 µg/L), 1,2,4-trimethylbenzene (up to 47 µg/L), 1,3,5-trimethylbenzene (up to 31 µg/L), and naphthalene (up to 32 µg/L). Trace amounts of the gasoline additive MTBE (<5 µg/L) were detected in downgradient Wells 085-236 and 085-237. MTBE was also detected in a sample from upgradient Well 085-235. Tetrachloroethylene (PCE) (up to 37 µg/L) was also detected in a number of Service Station area wells, and is probably related to historical degreasing operations. In June 2000, BNL implemented the *Groundwater Protection Contingency Plan* and formed a technical team to identify the source of the contamination. An evaluation of current operations indicates that the underground storage tanks and associated distribution lines are not leaking and that all waste oils and used solvents are being properly stored and recycled. Therefore, it is believed that the petroleum hydrocarbons and PCE detected in groundwater are from historical vehicle maintenance and fuel dispensing operations.

Between June and October 2000, concentrations of petroleum hydrocarbon related compounds in samples collected from Well 085-236 and 085-237 decreased to nearly nondetectable levels. During this same period however, levels of petroleum hydrocarbon related compounds increased in Well 085-17 from near nondetectable levels to concentrations well above NYS AWQS. By October 2000, samples from Well 085-17 had total xylene concentrations of 120 µg/L, 1,2,4-trimethylbenzene concentrations at 21.6 µg/L,

1,3,5-trimethylbenzene at 12.7 µg/L, and naphthalene at 4.0 µg/L. The shift in the detection of petroleum hydrocarbon related contaminants from Well 085-236 to Well 085-17 corresponds to a change in groundwater flow direction from southeast to south that began in June-July 2000. This change in flow direction was caused by the operation of the nearby carbon tetrachloride extraction wells.

In April 2000, the Environmental Restoration Program installed two additional wells (085-238 and 095-183) approximately 200 feet (61 m) downgradient of the Service Station in an effort to better characterize the extent of carbon tetrachloride contamination. Results from the initial sampling of these wells in early June indicated carbon tetrachloride up to 2,080 µg/L and tetrachloroethylene up to 12.6 µg/L. The lack of petroleum hydrocarbon compounds at this distance away from the Service Station is consistent with the findings of numerous studies on petroleum hydrocarbon spills, where it has been found that compounds such as xylenes, ethylbenzene, 1,2,4-trimethylbenzene, and naphthalene degrade rapidly and, therefore, do not migrate great distances from source areas.

#### 7.5.2.5 MAJOR PETROLEUM FACILITY (MPF)

The Central Steam Facility supplies steam for heating to all major facilities of the Laboratory through an underground distribution system. The MPF is the storage area for most fuels used at the Central Steam Facility. Five shallow Upper Glacial aquifer wells monitoring the MPF were initially installed as part of the licensing requirements for this facility, and are screened across the water table so that potential free product (i.e., oil floating on top of the groundwater) can be detected. As part of the Laboratory's Groundwater Monitoring Improvements Project, three additional surveillance wells were installed in early 2000 to improve monitoring of the MPF area. Additional surveillance wells are located in the CSF area. These wells are used to monitor groundwater contamination resulting from a 1977 leak of approximately 25,000 gallons (94,625 liters) of Alternative Liquid Fuel (a fuel oil/spent solvent mixture). Contaminated soils and groundwater near the 1977 spill site have been undergoing active remediation since the winter of 1997 (see Section 7.6.4.1).

*Volatile and Semivolatile Organic Compounds*

In accordance with the Special License Conditions for the MPF, groundwater samples are analyzed semiannually for the Polynuclear Aromatic and Base Neutral Compounds contained in EPA test Method 625. During 2000, none of these compounds were detected. The MPF wells were tested monthly for the presence of floating petroleum hydrocarbons. As in previous years, no floating petroleum product was observed.

In addition to the required testing for semi-VOCs, BNL also analyzed samples collected in October for the presence of VOCs. TCA was detected in upgradient Well 076-25 at concentrations of 25 µg/L. Low levels (up to 2 µg/L) of tetrachloroethylene and 1,1-dichloroethylene were also detected in several wells. The NYS AWQS for these compounds is 5 µg/L. The detection of TCA in upgradient Well 076-25 is consistent with historical monitoring results and it is believed that the TCA originates from contaminated soils associated with historical operations at Building 650.

#### 7.5.2.6 WASTE MANAGEMENT FACILITY (WMF)

In 1997, BNL began operating a new WMF. The new WMF is designed and operated in a manner that meets all applicable federal, state, and local environmental protection requirements. Nevertheless, BNL established a voluntary groundwater monitoring program as a secondary means of verifying the effectiveness of the facility's administrative and engineered controls. The new WMF is monitored by eight shallow Upper Glacial aquifer wells.

*Volatile Organic Compounds, Metals, and Anions*

Groundwater quality in the WMF area is monitored using eight wells. During 2000, all water quality and most metals concentrations were below the applicable NYS AWQS. Sodium was detected at concentrations above the NYS AWQS of 20 mg/L in upgradient Wells 055-03 and 066-07 at maximum concentrations of 47.4 mg/L and 22.7 mg/L, respectively. The detection of low levels of sodium is not uncommon in wells located within the developed area of the site and could be related to road salting operations. These low levels of sodium have not impacted the operation of nearby drinking water Wells 11 and 12. 1,1,1-Trichloroethane (TCA) and 1,1-Dichloroethylene (DCE) were detected in

upgradient Well 066-07 at concentrations up to 153 µg/L and 35 µg/L, respectively. The NYS AWQS for TCA and DCE is 5 µg/L. It is believed that the TCA and DCE contamination detected in Well 066-07 is due to historical releases from Building 830. Historically, the operations of nearby drinking water Wells 11 and 12 have been impacted by low level TCA contamination. Water pumped from these wells is treated by activated carbon filters prior to distribution. In December 2000, BNL initiated an investigation to verify the source of the VOC release.

*Radionuclides*

During 2000, no radionuclides related to Laboratory operations were detected in WMF area wells. Gross radioactivity levels in samples collected from the WMF wells were generally typical of background levels. However, one sample from upgradient Well 066-83 had a gross beta concentration of 61 pCi/L (2.3 Bq/L), which exceeded the 50 pCi/L (1.8 Bq/L) drinking water standard. It is likely that the elevated gross beta concentration is due to naturally occurring radionuclides such as potassium-40. Compared to previous years results, low levels of cobalt-60 (<10 pCi/L or <0.4 Bq/L) were not detected in samples collected from upgradient Well 066-07 during 2000. The source of the cobalt-60 was historical releases that occurred at Building 830.

#### 7.5.2.7 BIOLOGY DEPARTMENT GREENHOUSE AREA

The Biology Department facility includes 11 greenhouses where various types of plants are grown for biological research. Eight of the greenhouses have dirt floors and three have concrete floors. Pesticides and fertilizers have been routinely used in the greenhouses. Records also indicate that copper sulfate was applied to the dirt floors on an annual basis until the mid-1980s. The pesticide Endosulphan II was detected in soil samples collected from a dry well located within Greenhouse 10.

*Metals, Anions and Pesticides*

Two wells are used to monitor groundwater quality in the greenhouse area. The wells were sampled in May and September 2000, and tested for pesticides, metals, and anions. Groundwater monitoring results for 2000 indicate that current greenhouse operations are not impacting groundwater quality. Pesticides were not detected in any of the samples and all water quality and most metals concentrations were below the applicable NYS AWQS. Sodium was detected at concentrations slightly above the standard of 20 mg/L in the samples collected from both wells in May. The detection of low levels of sodium is not uncommon in wells located within the developed area of the site and could be related to road salting operations.

#### 7.5.2.8 SHOTGUN RANGE

The BNL Shotgun Range is used for trap and skeet target shooting by the Brookhaven Employees Recreation Association. The shotgun range is located in an isolated, wooded area north of the new Waste Management Facility. The range was established in 1974. Clay targets are thrown south from the trap house into an open field that is approximately 205 feet (62 m) east-west by 410 feet (125 m) north-south. Although most of the shot falls within the cleared range, shooting from several of the trap line positions results in the deposition of some of the shot into the nearby wooded areas.

From 1974 until 2000, the shotgun shells used at the facility typically contained lead pellets. It is estimated that as many as 30,000 shotgun rounds per year have been used at the range. At an average of 1.125 oz. per round, as much as 2,100 pounds (954 kg) of lead may have been deposited on the surface of the range annually. To prevent additional deposition of lead, in early 2000 BNL implemented a rule that allows only steel shot to be used at the range.

*Metals and Anions*

The three Shotgun Range groundwater monitoring wells were sampled in May and September 2000. All water quality (e.g., chlorides, sulfates and nitrate) and metals concentrations were below the applicable NYS AWQS and were consistent with established background levels for Long Island. Lead was not detected in any of the groundwater samples.

#### 7.5.2.9 LIVE-FIRE RANGE

The BNL Live-Fire Range consists of a six-position, 100-yard (91 m), bermed out door small arms and grenade range. The primary use of the current facility is to allow members of the BNL Safeguards and Security group to

practice and qualify in the use of firearms and to gain experience in the use of smoke and tear gas grenades. Federal law enforcement agencies and the Brookhaven Employees Recreation Association also occasionally use the range.

The Live-Fire Range was constructed in 1986 and is located immediately to the north of the BNL Sewage Treatment Plant. The eastern half of the range is located within 200 feet (61 m) of the Peconic River. The small arms and grenade ranges are co-located, side-by-side. The bullet stop at the range is an earthen berm, and bullets are known to have a typical penetration depth of approximately two to three inches into the berm. The soil of the rear berm is periodically screened to a depth of approximately one foot (0.305 m). The lead shot recovered during the screening process and the spent brass cartridges are disposed of offsite via a commercial waste handler as scrap metal. The grenade range is essentially an open field surrounded by earthen berms.

*Metals and Anions*

The two Live-Fire Range wells were sampled in May and September 2000. All water quality and metals concentrations were below the applicable NYS AWQS and were consistent with established background levels for Long Island. Lead was not detected in any of the samples.

## 7.6 ENVIRONMENTAL RESTORATION (ER) GROUNDWATER MONITORING PROGRAM

The mission of the ER groundwater monitoring program is to monitor the various contaminant plumes located onsite and offsite, as well as to monitor the progress that the groundwater treatment systems are making on plume remediation. The groundwater monitoring information described below provides an overview of ER groundwater monitoring and remediation activities for 2000. During this period, a total of 563 groundwater surveillance wells were monitored during approximately 2,180 individual sampling events. All wells sampled during 2000 are listed in Appendix E. Detailed analytical results for the ER Program are provided in the *BNL CY 2000 Groundwater Status Report* (BNL 2001).

Maps showing the main VOC and radionuclide plumes are provided as Figures 7-6 and 7-7. For each significant contaminant source area and plume described below, specific groundwater contaminant distribution maps are provided. These maps depict the areal extent of contamination, and were created by selecting the highest contaminant concentration observed for a given set of wells during a selected sampling period. Associated cross sections showing the vertical distribution/extent of contamination, as well as the hydrogeology for the BNL site and surrounding areas are described in the *BNL CY 2000 Groundwater Status Report* (BNL 2001).

### 7.6.1 BACKGROUND MONITORING

Background groundwater quality for the BNL site is monitored through a network of 13 wells located in the northern portion of the site and in offsite areas to the north. The site background wells provide information on the chemical and radiological composition of groundwater that has not been affected by activities at BNL. These background data are a valuable reference for comparison with groundwater quality data from areas that have been affected. This well network can also provide warning of any contaminants originating from potential sources of contamination that may be located upgradient of the BNL site.

There were no significant detections of VOCs in background wells. The highest concentration detected was chloroform at 2.2 µg/L in Well 000-120, which is a shallow Upper Glacial aquifer well, located immediately north of the northwest corner of the site. The NYS AWQS for chloroform is 7 µg/L. Historically, low concentrations of VOCs have been detected in some background wells. All radionuclide concentrations were consistent with natural levels.

### 7.6.2 OPERABLE UNIT I

#### 7.6.2.1 FORMER LANDFILL, ANIMAL/CHEMICAL PITS AND GLASS HOLES

The Former Landfill area was initially used by the U.S. Army as a landfill area during World Wars I and II. Then BNL used the southeast corner of the landfill from 1947 through 1966 for disposal of construction and demolition debris, sewage sludge, chemical and low-level radioactive waste, used equipment, and animal carcasses. From 1960 through 1966, BNL waste, glassware containing chemical and radioactive waste, and animal

carcasses containing radioactive tracers were disposed of in shallow pits in an area directly east of the Former Landfill. From 1966 through 1981, BNL disposed of used glassware in shallow pits located directly north of these chemical/animal pits. The Former Landfill was capped in 1996 and the Animal/Chemical Pits and Glass Holes were excavated in 1997.

A network of eight monitoring wells is used to monitor the Former Landfill area. The monitoring program for the Former Landfill is designed in accordance with post-closure operation and maintenance requirements specified in 6 NYCRR Part 360, "Solid Waste Management Facilities." These requirements specify that the well network be monitored quarterly for a minimum of five years, after which time BNL may petition NYSDEC to modify the frequency and types of analyses based on supporting data. The objective of this program is to monitor radiological and nonradiological contamination in the shallow Upper Glacial aquifer immediately downgradient of the landfill. The program was initiated following the capping of the Former Landfill in November 1996, to verify whether the cap effectively prevents the continued leaching of contaminants from the landfill, and to document anticipated long-term improvements to groundwater quality. In addition to these wells, BNL established a separate network of 24 wells to monitor the Animal/Chemical Pits and Glass Holes areas, and the downgradient portions of the Former Landfill plume. The downgradient portions of these plumes are currently being monitored as part of the OU I/IV Pre-Record of Decision Monitoring Program.

*Volatile Organic Compounds*

The areal extent of VOC contamination from the Former Landfill - Animal/Chemical Pits and Glass Holes area is shown on Figure 7-9. The primary chemical contaminants observed in the Former Landfill - Animal/Chemical Pits and Glass Holes plume are carbon tetrachloride (CT), TCA, 1,1-dichlroethylene (DCE), trichloroethylene (TCE), tetrachloroethylene (PCE) and chloroform. The plume is approximately 9,700 feet (2,956 m) in length from the Former Landfill source areas to just south of Crestwood Drive in North Shirley. The plume is defined by areas having total volatile organic compound (TVOC) concentrations greater than 5 µg/L. (Note: The NYS AWQS for most of the compounds listed is 5 µg/L. A TVOC concentration is the sum of all individual VOC concentrations detected in a given sample.) The area of the plume showing the highest TVOC concentration is located offsite near Sleepy Hollow Drive in North Shirley, and is composed primarily of CT and PCE, with a maximum TVOC concentration of 151 µg/L detected in Well 000-154. In general, VOCs are found in the shallow Upper Glacial aquifer in the vicinity of the Former Landfill, Animal/Chemical Pits and Glass Holes area, in the middle Upper Glacial aquifer at the southern site boundary, and in the deep Upper Glacial aquifer south of BNL. For a more detailed discussion on the vertical distribution of VOC contamination, see the *BNL CY 2000 Groundwater Status Report* (BNL 2001).

A comparison of the TVOC plume distribution from 1997 through 2000 is shown on Figure 7-9. Comparison of the groundwater data indicates that the capping of the Former Landfill in November 1996 and the excavation of the Chemical/Animal Pits and Glass Holes in September 1997 have contributed to the decline of TVOC concentrations to below 5 µg/L in shallow wells located near the source areas. Since 1997, TVOC concentrations greater than 1,000 µg/L that were observed in the vicinity of Stratler Drive, Shirley, have declined to less than 250 µg/L. Construction of the North Street Groundwater Remediation System is planned for late 2001, and will focus on reducing the high concentration VOC contamination in this area (see Figure 7-17).

*Radionuclides*

Strontium-90 has been routinely detected in groundwater in the Former Landfill, Animal/Chemical Pits and Glass Holes areas at concentrations above the drinking water standard of 8 pCi/L (0.3 Bq/L); specifically in Wells 106-16, 106-13, 097-03, and 097-64. There are two strontium-90 plumes (as defined by the 8 pCi/L standard) that are located close to the source areas. One plume originates from the Former Landfill and the second originates from the Animal/Chemical Pits area (Figure 7-10).

Comparison of the groundwater data indicates that the capping of the Former Landfill in November 1996 has contributed to

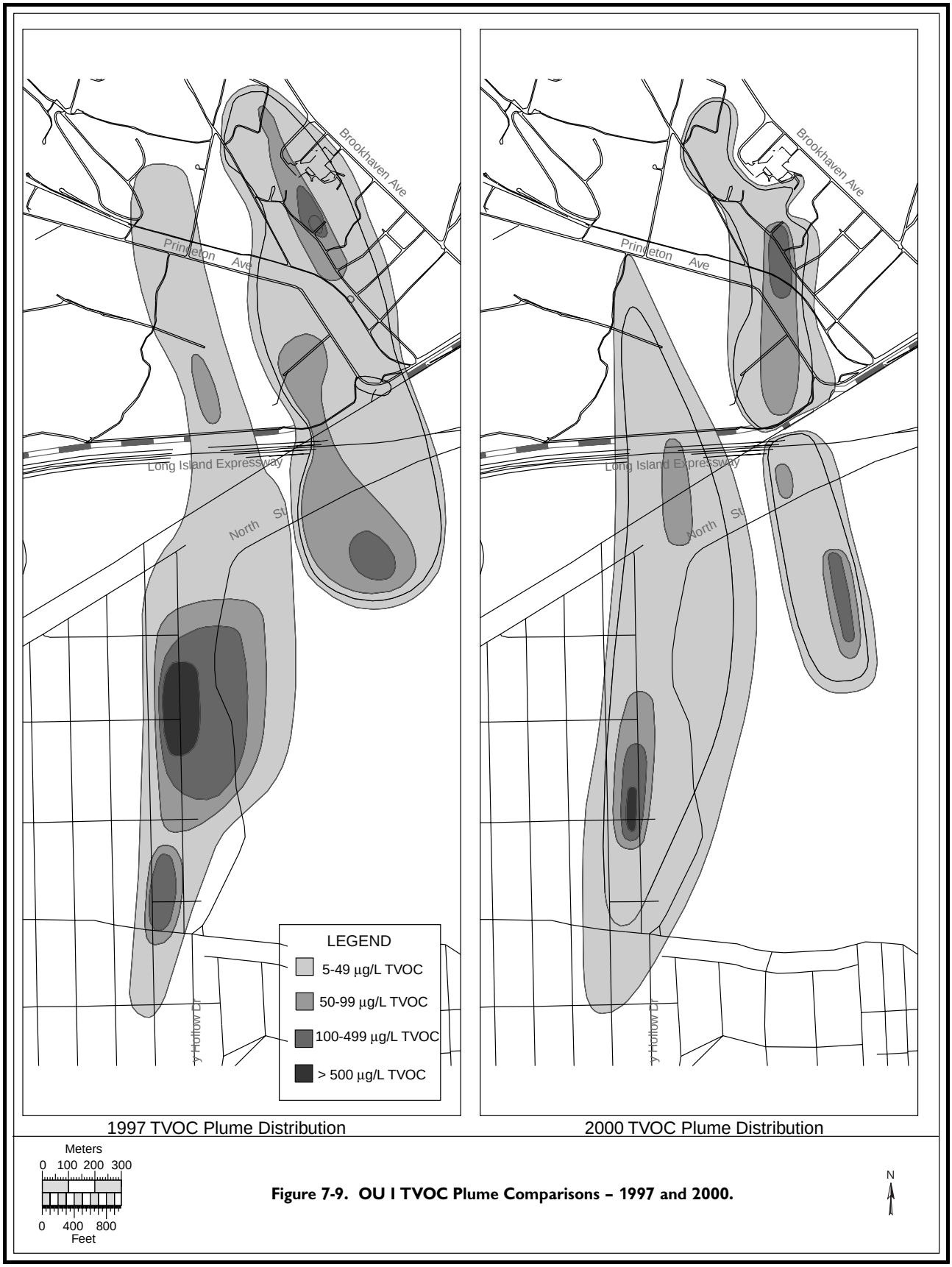


**Figure 7-9. OU I TVOC Plume Comparisons – 1997 and 2000.**

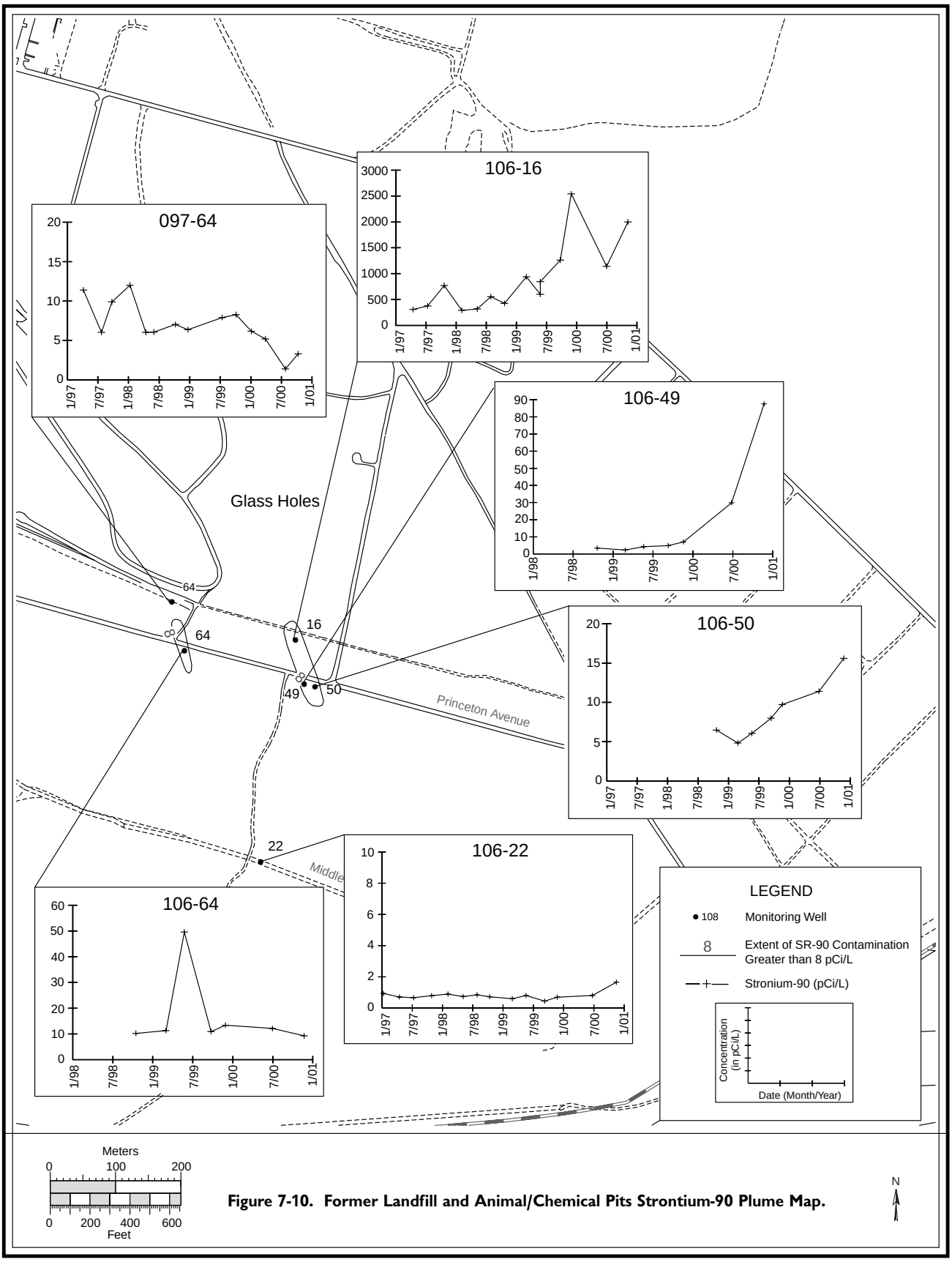


**Figure 7-10. Former Landfill and Animal/Chemical Pits Strontium-90 Plume Map.**

the decline of strontium-90 concentrations to below 8 pCi/L (0.3 Bq/L) in shallow wells located near the source areas. The highest strontium-90 concentration was 9.3 pCi/L (0.34 Bq/L) detected in Well 106-64, which is located approximately 350 feet (107 m) downgradient of the Former Landfill. Much higher strontium-90 concentrations were detected in areas downgradient of the Animal/Chemical Pits and Glass Holes area. Well 106-16, located immediately downgradient of the Animal/Chemical pits area, showed a maximum concentration of 2,000 pCi/L (74 Bq/L) in November 2000. Historical trends in strontium-90 concentration for key wells are presented in Figure 7-10. The leading edge of the Animal/Chemical Pits strontium-90 plume has migrated towards Wells 106-49 and 106-50 (located approximately 450 feet [137 m] downgradient) as evidenced by increasing strontium-90 concentrations in these wells during 2000.

#### 7.6.2.2 CURRENT LANDFILL

The Current Landfill operated from 1967 through 1990. (Note: This landfill is called the Current Landfill to distinguish it from the older [Former] landfill that closed in 1966.) It was used for disposal of putrescible waste, sludge containing precipitated iron from the Water Treatment Plant, and anaerobic digester sludge from the Sewage Treatment Plant. The latter contained low concentrations of radionuclides, and possibly metals and organic compounds. BNL also disposed of limited quantities of laboratory wastes containing radioactive and chemical material at the landfill. As a result, the Current Landfill is a source of groundwater contamination. Permanent closure (capping) of this landfill was completed in November 1995 as part of the ER Program.

The Current Landfill post-closure groundwater monitoring program consists of a network of 11 monitoring wells situated adjacent to the landfill, in both upgradient and downgradient locations. These wells are monitored quarterly to determine the cap's effectiveness in preventing the continued leaching of contaminants from the landfill, and to document the anticipated long-term improvements to groundwater quality. The monitoring well network was designed in accordance with New York State specified landfill post-closure Operation and Maintenance requirements.

*Volatile Organic Compounds*

Although VOCs continue to be routinely detected in wells located immediately downgradient of the landfill, their concentrations have decreased in response to the capping of the landfill. The highest TVOC concentration observed during 2000 was 36 µg/L, detected in Well 88-109. Well 88-109 is a shallow water table well located at the southeast corner of the landfill. A detailed discussion of the groundwater monitoring results for the Current Landfill area are included in the *BNL CY 2000 Groundwater Status Report* (BNL 2001).

*Radionuclides*

As in previous years, low levels of tritium and strontium-90 were detected in Current Landfill monitoring wells during 2000, but at concentrations well below their applicable drinking water standards of 20,000 pCi/L (740 Bq/L) and 8 pCi/L (0.3 Bq/L), respectively. The highest tritium value was 1,950 pCi/L (72 Bq/L) in Well 088-11, and the highest strontium-90 value was 4.9 pCi/L (0.2 Bq/L) detected in Well 088-21.

#### 7.6.2.3 FORMER HAZARDOUS WASTE MANAGEMENT FACILITY (HWMF) AND DOWNGRADIENT SECTION OF CURRENT LANDFILL PLUME

Groundwater contamination originating from the former HWMF and the downgradient section of the Current Landfill plume is being monitored under the Removal Action V (RA V) program. Until 1997, the former HWMF was BNL's central facility for processing, neutralizing, and storing hazardous and radioactive wastes before offsite disposal. As the result of past waste handling and storage practices, groundwater at the former HWMF is contaminated with both chemicals and radionuclides at concentrations that exceed NYS AWQS or DWS.

The Current Landfill and former HWMF plumes become commingled south of the HWMF due, at least partially, to historical pumping and recharge effects of the former Spray Aeration System, which operated from 1985 to 1990. The Spray Aeration System was designed to treat VOC-contaminated groundwater originating from the HWMF. The Current Landfill/HWMF plume is currently being remediated using a groundwater extraction and treatment system consisting of two wells screened in the deep portion of the

Upper Glacial aquifer at the site boundary (the RA V Treatment System is described in Section 7.7.3). This system provides hydraulic containment of those onsite portions of the plume that have TVOC concentrations greater than 50 µg/L.

The RA V monitoring program uses a network of 54 monitoring wells located in areas downgradient of the Current Landfill and HWMF. For a detailed description of the RA V remediation system and its effects on the VOC plume, refer to the *BNL CY 2000 Groundwater Status Report* (BNL 2001).

*Volatile Organic Compounds*

TVOC concentration distributions for the Current Landfill/HWMF plume are shown in Figure 7-9. The primary VOCs found onsite include chloroethane and DCA; whereas TCA, DCE, TCE, and chloroethane are found in the offsite portion of the plume. The Current Landfill/HWMF plume, as defined by TVOC concentrations greater than 5 µg/L, extends from the Current Landfill south to an area south of North Street, a distance of approximately 7,150 feet (2,180 m). Chloroethane, TCA, and DCA are detected in the shallow Upper Glacial aquifer near the source areas, and in the deep Upper Glacial aquifer at the site boundary and offsite. The maximum TVOC level detected onsite was in Well 098-59, at a concentration of 145 µg/L. TCA, DCE, TCE, and chloroform are found in the middle to deep Upper Glacial aquifer offsite south of North Street, with TVOC concentrations up to 129 µg/L detected in Well 000-124. Cross sectional views of the plume are presented in the *BNL CY 2000 Groundwater Status Report* (BNL 2001).

There have been several distinct changes in the distribution of the plume from 1997 through 2000 as shown on Figure 7-9. In general, the width of the plume has significantly decreased. The onsite reduction in plume width can be attributed to the effects of the groundwater extraction system located at the site boundary. Hydraulic control of the plume at the site boundary has been achieved as evidenced by the groundwater flow patterns in this area, and the decrease in contaminant concentrations (less than 20 µg/L) in Well 000-138 located downgradient of the extraction wells. A new groundwater treatment system (North Street East) is scheduled to be constructed in 2003. This treatment system is designed to remediate the high concentration portion of the VOC plume located offsite (see Figure 7-17).

*Radionuclides*

During 2000, tritium was detected in several wells, but at concentrations well below the 20,000 pCi/L (740 Bq/L) drinking water standard. The maximum observed tritium concentration during 2000 was detected in Well 088-26, at a concentration of 1,260 pCi/L (47 Bq/L). Well 088-26 is located within the former HWMF. Low levels of strontium-90 were detected in three wells located within or immediately downgradient of the HWMF. Strontium-90 concentrations exceeded the 8 pCi/L (0.3 Bq/L) standard in Well 088-26, with a maximum concentration of 10 pCi/L (0.4 Bq/L) detected in August 2000.

### 7.6.3 OPERABLE UNIT (OU) III

The monitoring well network established to monitor the OU III VOC and radionuclide source areas and associated contaminant plumes is composed of approximately 180 monitoring wells positioned from the north-central portion of the site to the southern site boundary and offsite. The OU III groundwater monitoring program is specifically designed to address the following groundwater contamination and plume remediation issues:

- Monitor VOC plumes with identified or suspected sources in the AGS Complex, Paint Shop, former carbon tetrachloride (CT) underground storage tank area, former Building 96 area, and the Supply and Material area.
- Monitor the tritium plume associated with the High Flux Beam Reactor (HFBR) and strontium-90 plumes associated with the Waste Concentration Facility and the formerly operated Brookhaven Graphite Research Reactor (BGRR).
- Evaluate the effectiveness of the OU III south boundary groundwater pump-and-treat system initiated in June 1997. This monitoring program characterizes the effects of the pumping on the contaminant plume and provides the data necessary for making decisions on the future operations of the extraction wells (See Section 7.7.1).
- Monitor the offsite segment of the OU III plume and "outpost" wells located to the south (downgradient) of the defined extent

of the offsite VOC plume to provide data on future downgradient migration of the plume. Outpost wells are also situated in the southwestern portion of BNL, directly upgradient of the Suffolk County Water Authority's Parr Village Well Field located near the William Floyd Parkway. These wells provide an early warning if contaminants from BNL were to migrate toward the Suffolk County Water Authority wells.

#### 7.6.3.1 VOLATILE ORGANIC COMPOUND PLUMES

Figure 7-11 shows the areal extent of the OU III VOC plume and the OU IV VOC plume. The two plumes are so close to each other that it is difficult to represent them as distinct, separate plumes. The OU III VOC plume extends from the AGS Complex area in the central part of the site south to the vicinity of Flower Hill Drive in North Shirley, a distance of approximately 17,600 feet (5,360 m). The plume is approximately 5,000 feet (1,525 m) at its maximum width, as defined by TVOC concentrations greater than 5 µg/L. The higher concentration portion of the plume (i.e., containing concentrations greater than 50 µg/L) is approximately 1,900 feet (580 m) wide near the BNL southern boundary.

The OU III VOC plume is actually comprised of multiple commingled plumes originating from several sources. To determine the extent of VOC contamination, monitoring well data from 11 separate ER and Environmental Surveillance monitoring programs are evaluated. These monitoring programs include the OU III Central area, Southern Boundary area, Carbon Tetrachloride Plume, former Building 96 area, AS-Industrial Park area, Offsite Program, select downgradient wells from the HFBR tritium monitoring program, Alternating Gradient Synchrotron Complex area, and the Motor Pool and Service Station areas. The primary VOCs detected in onsite monitoring wells include TCA, PCE, and carbon tetrachloride (CT); whereas CT and PCE are the primary VOCs detected in offsite groundwater. In general, PCE, TCA, and CT are observed in the shallow portions of the Upper Glacial aquifer in the central portion of BNL and in the deep Upper Glacial aquifer and uppermost Magothy aquifer at the southern boundary and offsite areas.

During 2000, wells displaying the highest TVOC concentrations (i.e., greater than 1,000 µg/L) include the former Building 96 area, the former CT underground storage tank area, areas near the South Boundary Treatment System, and the offsite Industrial Park Treatment System area. A comparison of the OU III plume distribution from 1997 and 2000 is provided on Figure 7-11.

##### 7.6.3.1.1 FORMER BUILDING 96 AREA

The VOC plume in the former Building 96 area consists primarily of PCE, and lower concentrations of TCA, with TVOC concentrations up to 2,066 µg/L detected in Well 095-84. The NYS AWQS for each of these compounds is 5 µg/L. During 2000, construction began on an in-well air sparging system to remediate the Building 96 source area (Figure 7-17). This groundwater treatment system is expected to be operational in early 2001.

##### 7.6.3.1.2 FORMER CARBON TETRACHLORIDE TANK AREA

In April 1998, an inactive underground storage tank used for the storage of CT was excavated and removed. This tank was located approximately 200 feet (61 m) northeast of the Upton Service Station. Although groundwater samples collected from a nearby well had shown low-level concentrations of CT since 1995, samples collected in June 1998 revealed levels approaching 100,000 µg/L. The NYS AWQS for CT is 5 µg/L. It is now apparent that the increase in contaminant concentration was probably due to the spillage of residual CT during removal of the underground storage tank. A groundwater remediation system consisting of two extraction wells screened in the shallow Upper Glacial aquifer began operation in October 1999. The effects of the pump-and-treat system on the source area are apparent in the sharp decline in CT concentrations in wells near the former UST area (see Section 7.7.4 for a description of the treatment system). The leading edge of the CT plume appears to be located in the vicinity of onsite Recharge Basin HW located near Weaver Drive. During 2000, the highest CT concentrations (up to 4,400 µg/L) were detected in Well 085-17 located approximately 250 feet (76 m) downgradient of the former UST area.

##### 7.6.3.1.3 SOUTHERN BOUNDARY AREA

Hydraulic control of the OU III plume at the site boundary has been attained as can be

**Figure 7-11. OU III and OU IV TVOC Plume Comparisons – 1997 and 2000.**

seen in Figure 7-11. The OU III South Boundary treatment system consists of seven extraction wells, which pump water from the deep portions of the Upper Glacial aquifer to an air stripper for treatment (see Section 7.7.1). TVOC concentrations in monitoring wells located near the extraction well system are generally less than 100 µg/L. Several wells located immediately downgradient of the extraction wells show TVOC concentrations in the range of 50 µg/L to 150 µg/L. Groundwater modeling indicates that these wells are located within the stagnation zone (i.e., a zone where there is little groundwater movement) created by the extraction wells. The *BNL CY 2000 Groundwater Status Report* (BNL 2001) contains detailed information on the OU III South Boundary system operations and progress on the remediation effort.

##### 7.6.3.1.4 INDUSTRIAL PARK TREATMENT SYSTEM AREA

The portion of the OU III TVOC plume with concentrations greater than 1,000 µg/L extends from the offsite Industrial Park area to Carleton Drive in North Shirley. This plume, which consists primarily of CT, is located in the deep portions of the Upper Glacial aquifer and upper portion of the Magothy aquifer. A groundwater treatment system, consisting of seven in-well air stripping treatment wells, was installed in the industrial park located south of BNL in 1999 (see Section 7.7.2). The purpose of the in-well air stripping wells is to treat VOC contamination located in the deep Upper Glacial aquifer. Thirty-six monitoring wells were also installed in this area to monitor the effects of the system (i.e., hydraulic control and changes in VOC concentrations). Samples from deep wells located near the offsite Industrial Park indicate that there is significant CT and PCE contamination in the deep Upper Glacial aquifer and uppermost Magothy aquifer in that area. Deep Upper Glacial aquifer Well 000-253 and Magothy aquifer Well 000-130 had maximum TVOC concentrations of 9,780 µg/L and 3,169 µg/L, respectively. Additional characterization of VOC contamination in the Magothy aquifer began in 2000 and will be completed by the end of 2001.

A new groundwater remediation system is being planned for the remediation of the southern extent of the OU III plume. The treatment system will be located along the northern edge of the Town of Brookhaven Airport and is scheduled to be constructed by 2003 (see Figure 7-17).

#### 7.6.3.2 RADIONUCLIDE PLUMES

##### 7.6.3.2.1 HFBR TRITIUM PLUME

Following the January 1997 discovery of tritium in wells south of the HFBR, it was determined that the HFBR's spent fuel pool was leaking tritiated water at a rate of approximately six to nine gallons per day. To prevent additional release of tritiated water, the HFBR's spent-fuel pool was completely emptied in December 1997. During 1997, an extensive groundwater investigation demonstrated that the tritium plume remained completely onsite, and an interim remediation system was constructed to control the leading edge of the plume.

The HFBR tritium plume (defined by concentrations greater than 1,000 pCi/L [37 Bq/L]; one-twentieth of the drinking water standard) extends from the HFBR to an area immediately north of Weaver Drive, a length of approximately 3,000 feet (915 m) (Figure 7-12). The portion of the plume with concentrations exceeding the 20,000 pCi/L (740 Bq/L) drinking water standard extends from the HFBR approximately 2,500 feet (760 m) to the south. Additional groundwater characterization was conducted during 2000 to increase the definition of the high concentration segment of the tritium plume (concentrations greater than 500,000 pCi/L [18,500 Bq/L]). This high concentration portion of the plume extends in a narrow band from Temple Place to approximately 250 feet (975 m) south. During 2000, the highest tritium concentrations were detected in Wells 075-291 and 075-294 located near Temple Place, where tritium concentrations exceeded 1,000,000 pCi/L. In an effort to remediate the high concentration portion of the plume, a low-flow pumping program was conducted using temporary wells. During 2000, approximately 65,000 gallons (246,025 liters) of water was extracted and then transported to an approved offsite disposal facility.

Because tritium concentrations dropped to nondetectable levels, the HFBR Pump and Recharge System extraction wells were shut down and placed in a stand-by mode in September 2000 (see Section 7.7.5). The system will be restarted if tritium concentrations increase to

**Figure 7-12. HFBR Tritium Plume Comparisons – 1997 and 2000.**

greater than 20,000 pCi/L in wells located near Weaver Drive. A detailed analysis of monitoring and remediation efforts is presented in the *BNL CY 2000 Groundwater Status Report* (BNL, 2001).

#### 7.6.3.2.2 WASTE CONCENTRATION FACILITY (WCF) AND BROOKHAVEN GRAPHITE RESEARCH REACTOR (BGRR)/PILE FAN SUMP AREAS STRONTIUM-90 PLUMES

Historical waste handling operations at the WCF and operations at the former BGRR,

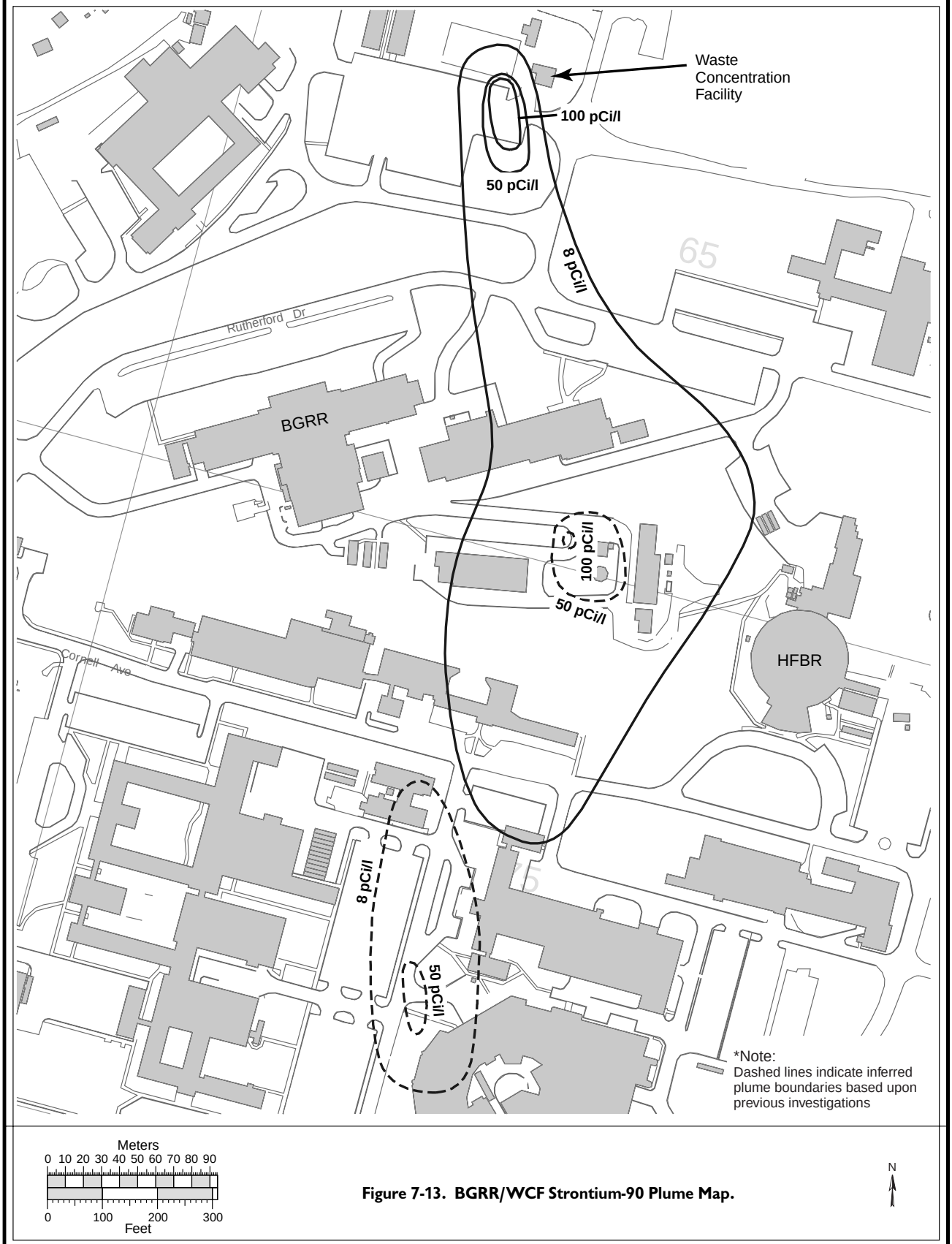


**Figure 7-13. BGRR/WCF Strontium-90 Plume Map.**

and its associated Pile Fan Sump, resulted in the release of strontium-90 to the groundwater below these facilities.

Two separate and distinct areas of strontium-90 contamination are recognized (Figure 7-13). The more significant of the two areas can be traced from the WCF area south to the area just north of Cornell Avenue, a distance of approximately 1,400 feet (425 m). The width of this plume, as defined by strontium-90 concentrations that exceed the 8 pCi/L (0.3 Bq/L) drinking water standard, is approximately 500 feet (150 m). The vertical extent of contamination is confined to the shallow and middle portion of the Upper Glacial aquifer. The highest concentration associated with the WCF plume is in shallow Well 065-175, at a concentration of 821 pCi/L (30 Bq/L). This well is located immediately downgradient of the WCF and is screened in the shallow portion of the Upper Glacial aquifer. A portion of this plume is composed of strontium-90 that was released in the Building 801 and nearby Pile Fan Sump area. This contamination is detected in shallow Upper Glacial aquifer wells located directly downgradient of the Building 801/ Pile Fan Sump area. The highest concentration associated with the Building 801/Pile Fan Sump portion of the plume is in shallow Well 065-172, at a concentration of 104 pCi/L (3.8 Bq/L).

The second area of strontium-90 contamination is located approximately 500 feet (150 m) south of the BGRR near Cornell Avenue. This plume, defined by strontium-90 concentrations greater than 8 pCi/L (0.3 Bq/L), extends approximately 550 feet (170 m) to an area just north of Brookhaven Avenue and is approximately 200 feet (60 m) wide. The highest concentration associated with the BGRR plume was detected in Well 075-199, at a concentration of 56 pCi/L (2 Bq/L).

In 2003, BNL will conduct additional characterization of the strontium-90 plumes to support the design of a new groundwater remediation system.

### 7.6.4 OPERABLE UNIT (OU) IV

The Operable Unit IV area contains two significant source areas: the 1977 fuel oil/ solvent spill site (AOC 5) and the Building 650 Sump and Sump Outfall area (AOC 6).

#### 7.6.4.1 1977 OIL-SOLVENT SPILL SITE (AOC 5)

In 1977, approximately 25,000 gallons (94,625 liters) of a mixture of Number 6 fuel oil and mineral spirits were released from a ruptured pipe used to transfer the contents from an underground storage tank to aboveground storage tanks at the Central Steam Facility (CSF). The OU IV plume is composed of the solvents TCA, PCE, DCE, and TCE, and oil products (consisting of toluene, ethylbenzene, and xylene). Although the main source area appears to be in the vicinity of the 1977 spill, the detection of low levels of TCA and PCE in several upgradient wells indicates that some of the contamination originates from historical spills that occurred in the nearby CSF and Building 650 areas. Whereas TCA, PCE, DEC, and TCE have migrated considerable distances, the presence of toluene, ethylbenzene, and xylene is highly localized to the source area.

An air sparging/soil vapor extraction system (AS/SVE) has been in operation since November 1997 to remediate VOC and semi-VOC contamination of soils and groundwater near the spill site (see Section 7.7.6). Compared to pre-November 1997 monitoring results (when TVOC concentrations were typically greater than 1,000 µg/L), VOC concentrations in most wells located within the spill area dropped to below the 5 µg/L remediation goal. However, in October 2000, TVOC concentrations rebounded to 361 µg/L in one well (076-04) located in the immediate vicinity of the 1977 spill. This rebound effect was expected, as it is typical during late stages of remediation.

Monitoring of wells downgradient of the 1977 spill site indicates that the OU IV plume is now cut off from the source area. The OU IV plume, as defined by TVOC concentrations greater than 5 µg/L, now extends from an area just west of the Former Landfill to an offsite area just south of the Long Island Expressway, a distance of approximately 4,000 feet (1,219 m) (Figure 7-11). In the downgradient portion of the OU IV plume, the highest VOC concentrations during 2000 were found in the area between Princeton Avenue and the southern site boundary, with TVOC concentrations up to 180 µg/L in Well 106-54. VOCs were also detected in the upper Magothy aquifer Wells 122-05 and 122-24 at 85 µg/L and 286 µg/L, respectively.

Extraction Well EW-12, of the OU III Southern Boundary treatment system, provides hydraulic control for the downgradient portion of the OU IV plume. The changes in the OU IV plume distribution from 1997 through 2000 are shown on Figure 7-11, which depicts the combined OU III and OU IV plumes. The *BNL CY 2000 Groundwater Status Report* (BNL 2001) contains detailed information on system operations and remediation progress.

#### 7.6.4.2 BUILDING 650 AND 650 SUMP OUTFALL AREAS (AOC 6)

During 2000, strontium-90 was not detected above the 8 pCi/L (0.3 Bq/L) drinking water standard in wells located downgradient of Building 650 (Figure 7-14). A strontium-90 concentration of 6.8 pCi/L (0.25 Bq/L) was detected in Well 76-28, which is located adjacent to the Building 650 sump/decontamination pad and downgradient of a former underground storage tank area. The strontium-90 detected in Well 076-28 probably originates from contaminated soils associated with decontamination pad and storage tank operations. Only a trace level of strontium-90 (0.5 pCi/L or 0.02 Bq/L) was detected in one of three wells located downgradient of Building 650.

Soil and groundwater contamination at the Building 650 Sump Outfall is due to the historical discharge of radionuclides to the Building 650 sump. The strontium-90 plume (defined by concentrations greater than 8 pCi/L [0.3 Bq/L] drinking water standard) extends from the 650 Outfall to Well 076-24, a distance of approximately 800 feet (240 m). During 2000, strontium-90 concentrations exceeded the drinking water standard in three downgradient wells, with the highest concentration observed in Well 076-169 at a concentration of 30.9 pCi/L (1.1 Bq/L).

### 7.6.5 OPERABLE UNIT V, EASTERN PLUME

The OU V monitoring program uses 34 monitoring wells located downgradient of the Sewage Treatment Plant (STP). These wells monitor VOC and tritium contamination resulting from historical releases at the STP. Surveillance of present groundwater quality at the STP is performed as part of the BNL Environmental Surveillance Program (see Section 7.5).

*Volatile Organic Compounds, Metals, and Pesticides*

The areal extent of VOC contamination is shown on Figure 7-15. The primary chemical contaminants found in the OU V Eastern VOC plume are TCE and TCA. The ambient water quality standard for both of these compounds is 5 µg/L. The Eastern VOC plume, defined by TVOC concentrations greater than 5 µg/L, extends from a location southeast of the STP to the Long Island Expressway offsite, a distance of approximately 5,300 feet (1,600 m). During 2000, the highest TVOC concentration was 33 µg/L, detected in Well 061-05 located at the site boundary near North Street (Figure 7-15). Vertically, the VOCs are present in the deep portions of the Upper Glacial aquifer. Monitored natural attenuation is the recommended remedial alternative for the VOC contamination at this time. A long-term remedy will be selected as part of the OU V Record of Decision.

Samples from key OU V wells were analyzed for Target Analyte List Metals, and samples from offsite wells were analyzed for pesticides/PCBs. None of the inorganic contaminants of concern initially identified during the OU V Remedial Investigation/Feasibility Study, including mercury and hexavalent chromium, were detected in 2000. Although trace amounts of the pesticides 4,4′-DDD and 4,4′-DDT were detected in several offsite wells during 1998, all samples collected during 2000 were nondetectable for these compounds.

*Radionuclides*

Detectable levels of tritium were found in a number of wells located near BNL's southeastern site boundary and several offsite wells. However, the concentrations were well below the drinking water standard of 20,000 pCi/L (740 Bq/L). In wells located near the southeastern site boundary, the maximum tritium concentration was detected in Well 50-02, at a concentration of 2,430 pCi/L (90 Bq/L). In offsite wells monitored during 2000, tritium was either nondetectable or just slightly above detection limits. (Note: The typical detection limit for tritium is 350 pCi/L [13 Bq/L].) A detailed discussion on the distribution of tritium within the OU V plume is provided in the CY *2000 Groundwater Status Report* (BNL 2001).

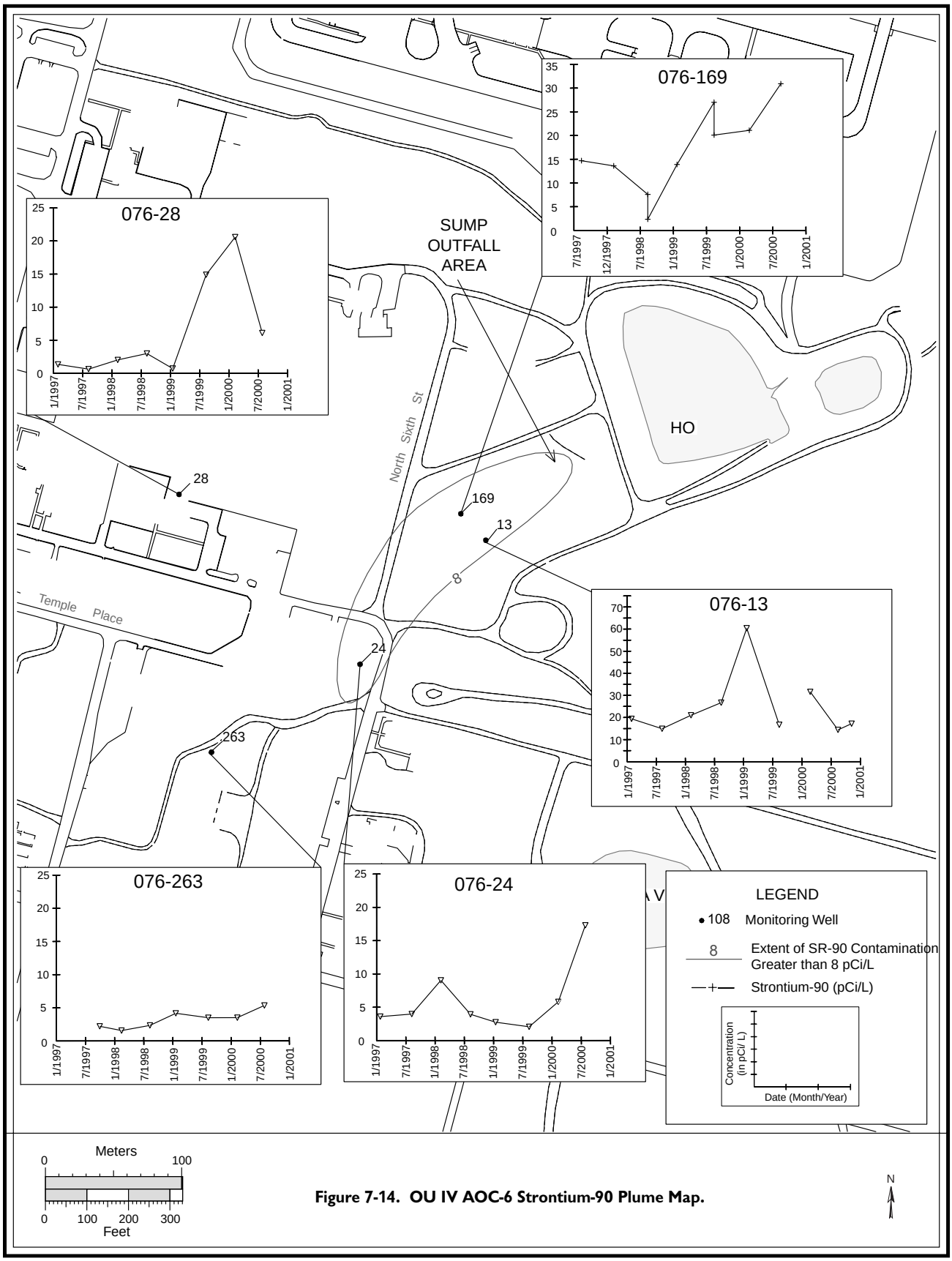


**Figure 7-14. OU IV AOC-6 Strontium-90 Plume Map.**

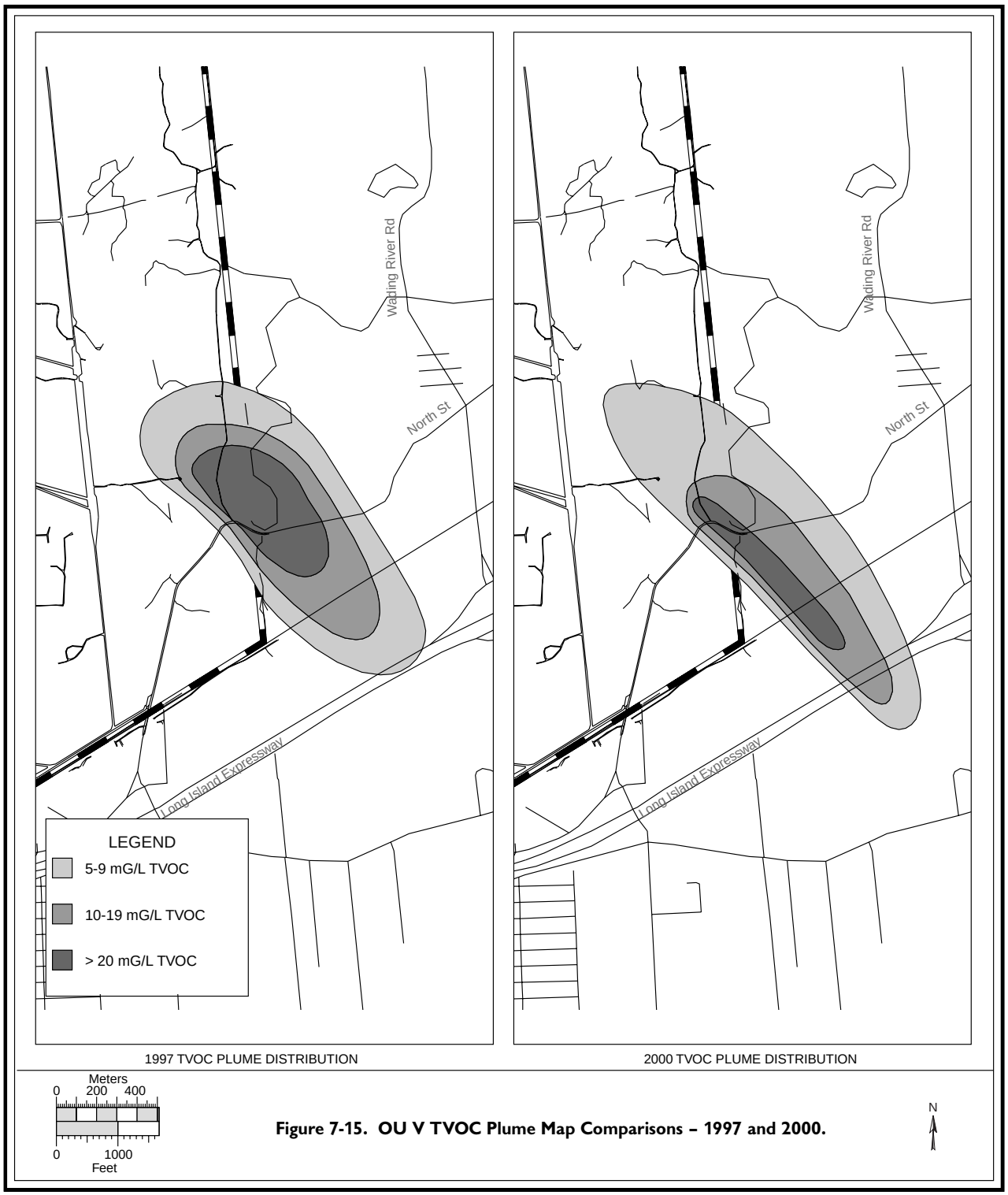


**Figure 7-15. OU V TVOC Plume Map Comparisons – 1997 and 2000.**

### 7.6.6 OPERABLE UNIT VI, BIOLOGY FIELDS

Ethylene dibromide (EDB) was used as a fumigant in the BNL Biology Department's agricultural fields located in the southeast portion of the site. Available records indicate that the application of EDB in this area took place in the 1970s. As the result of these historical releases of EDB, a contaminant plume (as defined by concentrations greater than the 0.05 µg/L drinking water standard for

**Figure 7-16. OU VI EDB Plume Comparison – 1997 and 2000.**

EDB) extends approximately 3,900 feet (1,190 m), from near BNL's southeastern site boundary to an area south of the Long Island Expressway (see Figure 7-16). EDB is the only contaminant of concern for the Biology Fields plume.

During 2000, the highest EDB concentration was found in offsite Well 000-175 (located south of North Street) at 2.8 µg/L. Vertically, EDB is found in the deep Upper Glacial aquifer at the southern site boundary and in offsite areas. Figure 7-16 shows a comparison

of the EDB plume from 1997 and 2000. The important changes in the plume are the downgradient migration of both the trailing edge of the plume and the area of highest EDB concentrations. A remediation system for this plume will be constructed by 2003.

## 7.7 GROUNDWATER TREATMENT SYSTEMS

The primary mission of BNL's Environmental Restoration Program is remediating soil and groundwater contamination, and preventing additional contamination from migrating off the BNL site. To that end, seven groundwater treatment systems are presently operating at BNL, and an eighth system (Former Building 97 Area) will be operational in 2001. Figure 7-17 shows the locations of these treatment systems. The following is a brief description of the groundwater treatment systems that were operational during 2000 along with a summary of their performance. Table 7-4 provides a summary of pounds of VOCs removed and gallons of water treated since the first treatment system became operational in 1997. During 2000, approximately 700 pounds (318 kg) of VOCs were removed from the groundwater, and more than one billion gallons (3.8 billion liters) of treated groundwater were returned to the aquifer. Detailed information on these treatment systems can be found in the *CY 2000 Groundwater Status Report* (BNL 2001).

### 7.7.1 OU III SOUTH BOUNDARY REMEDIATION SYSTEM

Construction of the OU III pump-and-treat system was completed in June 1997. The system uses seven wells to extract VOC-contaminated groundwater that originated from a number of sources located in the developed central portion of the BNL site. The water is pumped approximately one mile (1.6 km) north to an air-stripping tower located near the Medical Department complex, where air from a powerful blower separates the VOCs from the water. The removal efficiency is close to 100%. No VOCs were detected above the minimum detection limit (typically 0.5 μg/L) in treated water samples. The clean water is discharged to a nearby recharge basin, and the VOCs stripped from the water are released into the air at concentrations below state and federal emissions standards. The system processes approximately 600 gallons (2,271 liters) of water per minute. During 2000, approximately 325 pounds (148 kg) of VOCs were removed from the groundwater, and 381,700,000 gallons (1.4 billion liters) of treated groundwater were returned to the aquifer.

### 7.7.2 OU III OFFSITE GROUNDWATER TREATMENT SYSTEM

The OU III offsite groundwater remediation system became operational in the summer of 1999. The system was constructed south of the BNL site to remove VOC contamination that has migrated to an industrial area located between the Long Island Expressway and the residential areas of North Shirley. This remediation system consists of a series of innovative "in-well stripping" wells that use the same air stripping treatment concept as the OU III South Boundary Remediation System, but all treatment and recharge occurs within the well. Within each well, contaminated water is pumped from a deep well screen to a treatment system located near the top of the well, where VOCs are stripped from the water. The treated water is then routed to a shallower screened section of the same well where it reenters the aquifer. The VOC vapors are captured by a granular carbon filter. During 2000, approximately 177 pounds (80 kg) of VOCs were removed from 192,273,000 gallons (727 million liters) of groundwater.

### 7.7.3 OU I (RA V) SOUTH BOUNDARY REMEDIATION SYSTEM

This pump-and-treat system was completed in December 1996. The system uses two extraction wells to remove contaminated groundwater that originated from the Current Landfill (now closed and capped) and the former HWMF. The water is pumped approximately one mile north to an air stripper. This system processes more than 700 gallons (2,650 liters) of water per minute. Like the OU III South Boundary Remediation System, the RA V system removes close to 100% of the chemical contamination. No VOCs were detected above the minimum detection limit in treated water samples. The clean water is discharged to a nearby recharge basin, and the VOCs stripped from the water are released into the air at concentrations below state and federal emissions standards. During 2000, approximately 34 pounds (15 kg) of VOCs were removed from the groundwater, and

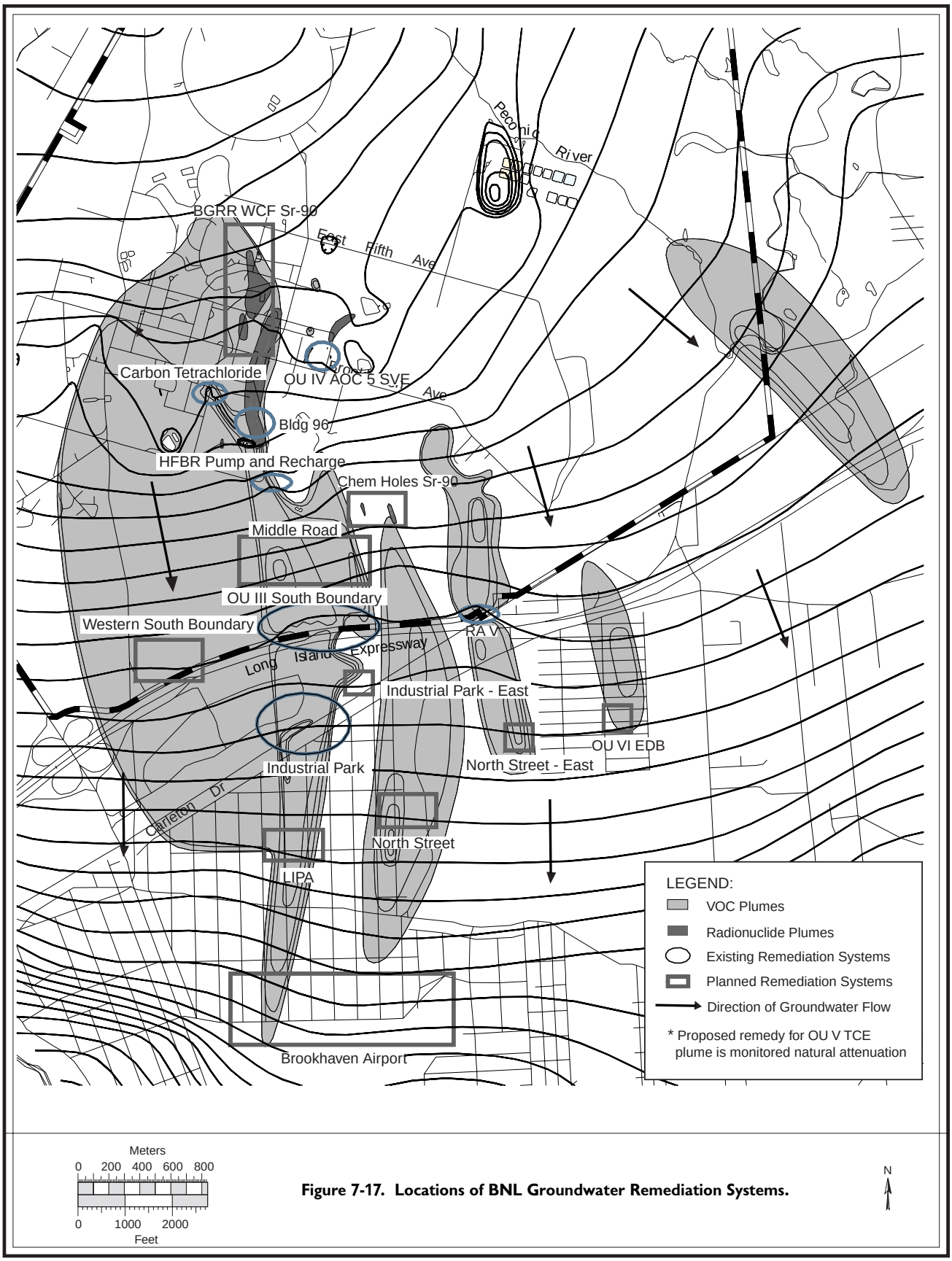


**Figure 7-17. Locations of BNL Groundwater Remediation Systems.**

**Table 7-4. BNL Groundwater Remediation Systems Treatment Summary for 1997 through 2000.**

| Remediation System | 1997 – 1999 | | 2000 | |
|---|---|---|---|---|
| | Water Treated (Gallons) | VOCs Removed (Pounds) | Water Treated (Gallons) | VOCs Removed (Pounds) |
| OU III South Boundary | 837,300,400 | 1,099 | 381,728,000 | 325 |
| OU III Offsite[a] | 35,300,000 | 63 | 192,273,000 | 177 |
| Carbon Tetrachloride[a] | 6,900,000 | 112 | 42,273,000 | 80 |
| RA V | 996,000,000 | 195 | 333,540,000 | 34 |
| HFBR Tritium Plume | 190,000,000 | 104 | 51,528,000[b] | 76 |
| OU IV AS/SVE[c] | — | 39 | — | 8 |
| Total | 2,065,500,400 | 1,612 | 1,001,342,000 | 700 |

Notes:
[a] Treatment system not installed/operational until 1999.
[b] System was shut down and placed in standby mode on September 29, 2000.
[c] Air Sparging/Soil Vapor Extraction system performance measured by pounds of VOC removed per cubic feet of air treated.

333,540,000 gallons (1.2 billion liters) of treated groundwater were returned to the aquifer.

#### 7.7.4 OU III CARBON TETRACHLORIDE TREATMENT SYSTEM

A groundwater remediation system consisting of two extraction wells screened in the shallow Upper Glacial aquifer began operations on October 6, 1999 to address the carbon tetrachloride released during the removal of an underground storage tank in early 1998. Groundwater extracted from this area is treated with carbon filtration and recharged back into the aquifer through an unlined drainage swale to Recharge Basin HS located south of Princeton Avenue. During 2000, approximately 80 pounds (36 kg) of VOCs were removed, and 42,273,000 gallons (160 million liters) of treated water were recharged to the Upper Glacial aquifer.

#### 7.7.5 OU III HFBR TRITIUM PLUME REMEDIATION SYSTEM

This groundwater pump and recharge system was constructed as an interim remedial action after the HFBR tritium plume was discovered, and has operated since May 1997. Three groundwater extraction wells were installed approximately 3,500 feet (1,070 m) south of the HFBR. Groundwater is pumped from the aquifer at a rate of about 40 gallons (151 liters) per minute and piped north to a treatment facility adjacent to the RA V treatment system. Because the water also contains VOCs that originate from another sources (possibly the former Building 96 area), the water is treated by passing it through a granular carbon filter to remove the VOCs before discharging the water to the RA V recharge basin. No VOCs were detected above the MDL in treated water samples; and tritium was not detected in samples collected at the influent to the treatment system (i.e., concentrations <500 pCi/L). This interim remediation system is designed to prevent the further southward migration of the HFBR tritium plume while long-term remediation options are evaluated and implemented. During 2000, the granular activated carbon filters removed approximately 76 pounds (35 kg) of VOCs, and 51,528,000 gallons (195 million liters) of treated water were recharged to the aquifer system. In September 2000, this treatment system was shut down because it was no longer needed to control the leading edge of the HFBR tritium plume. Remaining VOC contamination in the former Building 96 area will be remediated using a new system that is expected to begin operating in May 2001, and downgradient portions of the plume will be remediated using the planned OU III Middle Road Treatment System, which is expected to begin operations in July 2001.

#### 7.7.6 OU IV AIR SPARGING/SOIL VAPOR EXTRACTION SYSTEM

This remediation system, which has operated since November 1997, combines two technologies to remove VOC and semi-VOC contaminants from soil and groundwater located near the BNL Central Steam Facility. The system uses air sparging and soil vapor extraction that forces pressurized air into the groundwater to “bubble” or strip the volatile

compounds out of the water and soil and into a vapor phase. Powerful vacuum pumps then recover the resulting vapors and pipe them to a nearby treatment facility where the VOC vapors are removed by a granular carbon filter system before the air is released into the atmosphere. During 2000, approximately eight pounds (3.6 kg) of contaminants were removed from the soil and groundwater. Except for a slight rebound in VOC concentrations in one well, monitoring of wells within the treatment area indicated that VOC concentrations dropped to below cleanup standards. This is an indication that soil and groundwater remediation is nearly complete.

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Chapter 8

# Radiological Dose Assessment

Radioactive materials are used in many research activities at Brookhaven National Laboratory. The radiological impact of these materials and potential effective dose equivalents to members of the public from various pathways such as inhalation, ingestion, and skin absorption were evaluated to show compliance with EPA and DOE regulatory limits. During 2000, very low levels of radioactive gaseous and particulate emissions were released from facility operating stacks and ventilation exhausts.

BNL operations had minimal radiological dose impact to the public and the environment. The ambient external dose measured at BNL was similar to background levels. The effective dose equivalent to the maximally exposed individual from air emissions was calculated to be 0.18 mrem (1.8 μSv). This dose is insignificant when compared to the EPA regulatory public air-dose limit of 10 mrem/yr (100 μSv/yr). The annual effective dose equivalent to an individual consuming contaminated fish and deer was 3.10 mrem (31 μSv). The maximum dose impact to the individual from both the air and food pathways combined was 3.28 mrem (33 μSv). This is less than 4% of the DOE regulatory dose limit for members of the public from all pathways which is 100 mrem (1000 μSv).

Five remediation projects with potential air emissions of radionuclides in excess of 1% of the National Emissions Standards for Air Pollutants were also evaluated. This evaluation showed that the cumulative effective dose equivalent from all of these sources was 0.11 mrem (1.1 μSv).

In 2000, the dose to aquatic and terrestrial biota was also evaluated. No radiological doses either to aquatic or terrestrial animals or plants above natural background were recorded from BNL operations.

## 8.1 AMBIENT RADIATION

### 8.1.1 ONSITE AND OFFSITE AMBIENT RADIATION MONITORING

BNL continuously monitors ambient radiation doses from Laboratory operations using a system of passive area monitors called thermoluminescent dosimeters (TLDs). The TLDs are located onsite and offsite and measure direct external beta and gamma radiation. These TLDs are made of crystals, known as chips, that are made of calcium fluoride (Ca $F_2$:Dy) and lithium fluoride (LiF: Mg, Ti). The TLDs are suspended free in ambient air approximately three feet (one meter) above the ground surface.

Thirty-six TLDs were posted on the BNL site and 18 posted at offsite monitoring locations in 2000 as shown on Figures 8-1 and 8-2, respectively. Figure 8-1 does not show the location of 044-400 and 045-400 TLD as GPS readings were not available. The BNL site is divided into grids and the TLDs are assigned numbers based on these grids. The offsite TLDs do not have grid numbers and are assigned a grid of 000 followed by a unique numerical identifier. The offsite TLD locations are divided into 16 sectors for wind directions. The onsite and offsite TLDs were exchanged on a quarterly basis to determine whether BNL operations had any impact on the ambient external radiation levels of the surrounding area. The Table 8-1 correlated TLD number to location.

The control TLD 075-000 dose was calculated as an arithmetic average of 30 TLDs stored in a lead-shielded container (in Bldg. 535) to reduce dose from

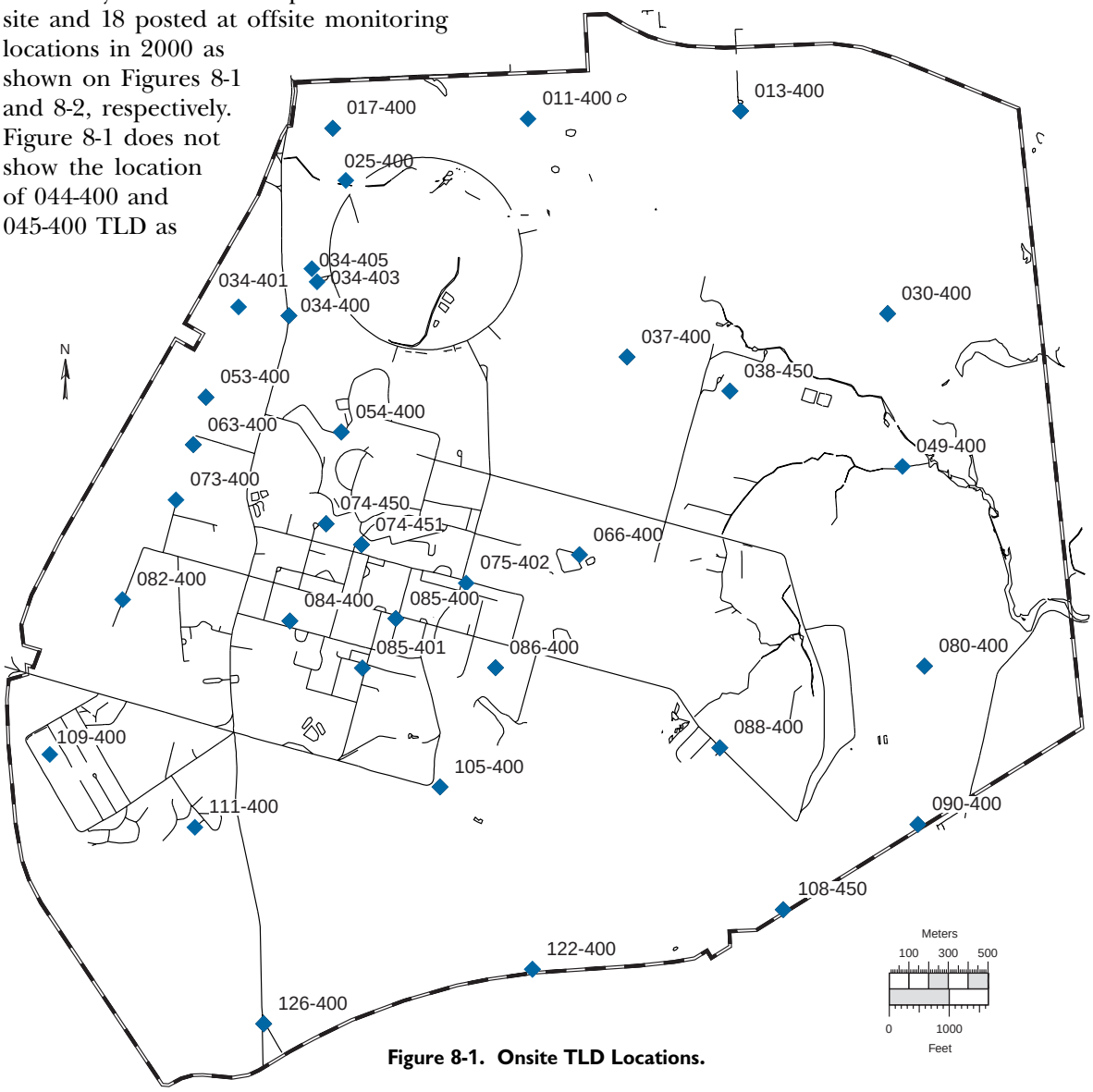


**Figure 8-1. Onsite TLD Locations.**

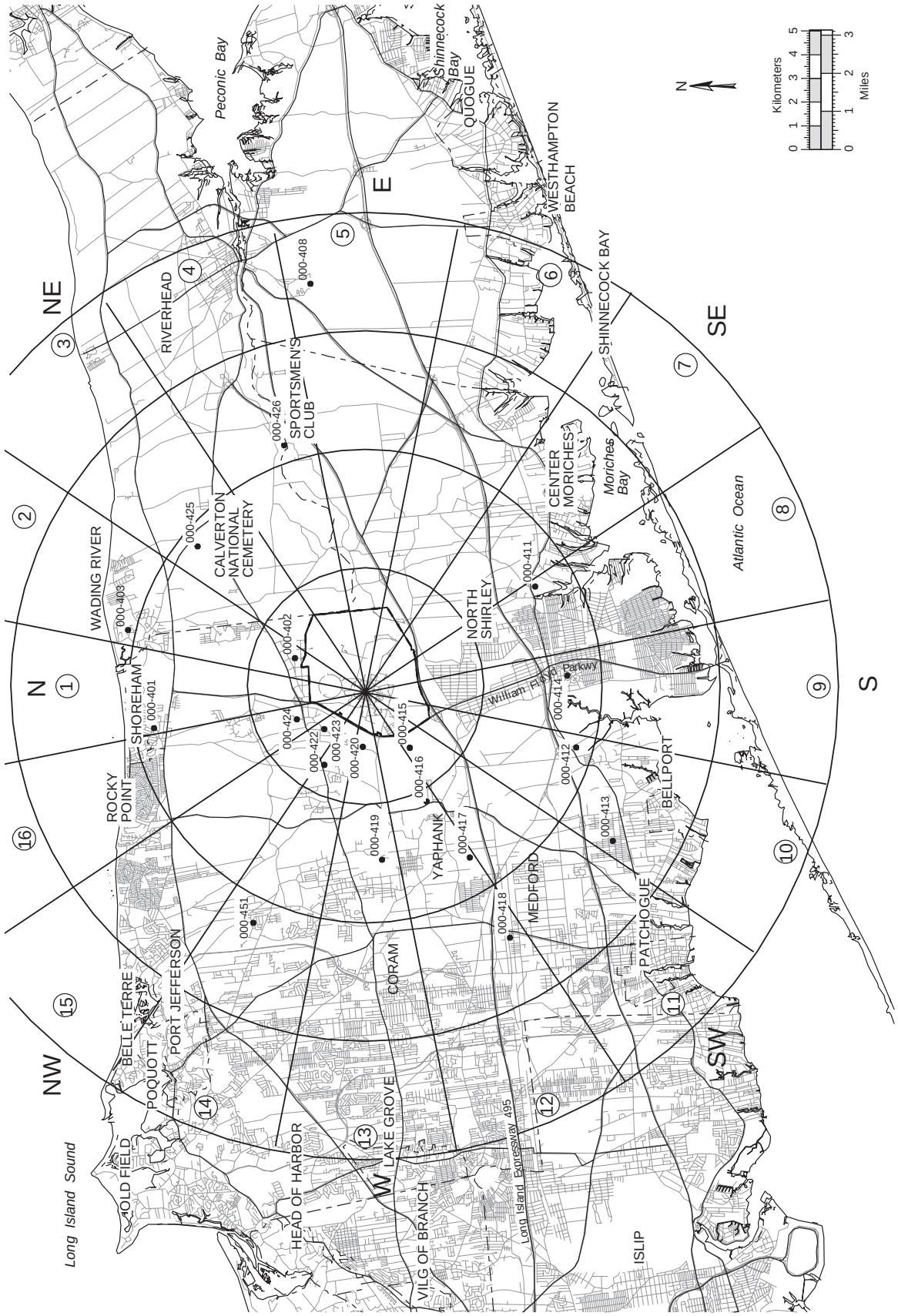


**Figure 8-2. Offsite TLD Locations.**

natural sources and cosmic radiation. The measured dose of the control TLD was 16 ± 10 mrem (0.16 ± 0.1 mSv) for each of the four quarters and 64 ± 40 mrem (0.64 ± 0.40 mSv) for the entire year. The highest dose recorded (104 ± 40 mrem /year [1.0 ± 0.4 mSv]) was measured at the West Firebreak (053-400). However, the large standard deviation associated with that measured value indicates significant variation in dose measurements at 95% probability. During 2000, the onsite and offsite ambient doses for all quarters were similar to natural background doses, with a few exceptions. The onsite average dose calculated for the 34 onsite TLDs was 88 ± 7 mrem (0.88 ± 0.07 mSv) per year. In comparison, the average of the 17 offsite TLDs was 86 ± 9 mrem (0.86 ± 0.09 mSv) per year.

The quarterly average and yearly dose for TLD 054-400 (Bldg. 914) was not calculated into the onsite average in Table 8-1 due to the large difference between the first and subse-

**Table 8-1. Onsite Ambient Radiation Measurements (CY 2000).**

| TLD # | Location | 1st Quarter (mrem) | 2nd Quarter (mrem) | 3rd Quarter (mrem) | 4th Quarter (mrem) | Average (mrem) | Annual Dose (mrem/year) |
|---|---|---|---|---|---|---|---|
| 011-400 | N. Firebreak | NR | NR | 18.1 | 22.0 | 20 ± 5 | 80 ± 20 |
| 013-400 | N. Firebreak | 21.4 | 19.3 | 18.7 | 22.4 | 21 ± 3 | 84 ± 12 |
| 017-400 | P2 | 19.3 | NR | 18.2 | NP | 19 ± 1 | 76 ± 4 |
| 030-400 | NE Firebreak | 21.1 | 18.9 | 18.8 | NP | 20 ± 3 | 80 ± 9 |
| 034-400 | N. Access Rd | 22.0 | 18.4 | 19.4 | 25.7 | 21 ± 6 | 84 ± 24 |
| 034-401 | N. Met | 24.0 | 21.8 | 21.2 | 24.9 | 23 ± 4 | 92 ± 12 |
| 037-400 | S13 | 22.0 | 19.8 | 19.8 | 23.0 | 21 ± 3 | 85 ± 12 |
| 038-450 | S5 | 20.5 | 18.6 | 18.4 | 22.8 | 20 ± 4 | 80 ± 16 |
| 049-400 | E. Firebreak | 20.3 | 17.3 | 18.5 | 21.4 | 19 ± 4 | 76 ± 16 |
| 053-400 | W. Firebreak | 26.7 | 32.8 | 20.1 | 25.7 | 26 ± 10 | 104 ± 40 |
| 063-400 | W. Firebreak | 23.3 | 19.1 | 20.4 | 25.2 | 22 ± 6 | 88 ± 24 |
| 066-400 | Sump H0 | 19.4 | 17.7 | 17.3 | 20.3 | 19 ± 3 | 76 ± 12 |
| 073-400 | W. Met / B#51 | 23.8 | NP | 22.4 | 28.0 | 25 ± 6 | 100 ± 24 |
| 074-450 | Bldg. 197 | NP | 23.8 | 22.4 | 26.6 | 24 ± 4 | 96 ± 16 |
| 074-451 | Bldg. 907 | 27.2 | 22.2 | 20.8 | 24.8 | 24 ± 6 | 96 ± 24 |
| 075-402 | Bldg. 356 | 26.8 | 22.4 | 25.4 | 29.9 | 26 ± 6 | 104 ± 24 |
| 080-400 | E. Firebreak | 22.9 | 18.2 | 19.6 | 25.6 | 22 ± 7 | 88 ± 28 |
| 082-400 | W. Firebreak | NP | 20.9 | 21.0 | 25.3 | 22 ± 5 | 88 ± 20 |
| 084-400 | Tennis Courts | 22.9 | 18.7 | 20.1 | 24.2 | 22 ± 5 | 88 ± 20 |
| 085-400 | TFCU | 23.7 | 19.6 | NP | 25.7 | 23 ± 6 | 92 ± 24 |
| 085-401 | Upton Gas Station | 27.1 | 18.8 | 20.0 | 26.9 | 23 ± 9 | 92 ± 36 |
| 086-400 | BERA Ball Fields | 22.9 | 21.1 | 20.3 | 26.0 | 23 ± 5 | 92 ± 20 |
| 090-400 | P7 | 23.1 | 20.6 | 20.0 | 23.6 | 22 ± 4 | 88 ± 12 |
| 105-400 | S. Firebreak | 23.2 | 21.0 | 19.6 | 25.2 | 22 ± 5 | 88 ± 20 |
| 108-450 | Water Tower | 21.7 | 21.3 | 20.5 | 24.2 | 22 ± 3 | 88 ± 12 |
| 109-400 | P4 | 22.7 | 19.9 | 20.6 | 24.0 | 22 ± 4 | 88 ± 12 |
| 111-400 | Trailer Park | 22.1 | 18.7 | 20.1 | 24.9 | 21 ± 5 | 84 ± 20 |
| 122-400 | S. Firebreak | 21.5 | 18.3 | 18.8 | 23.1 | 20 ± 4 | 80 ± 16 |
| 126-400 | S. Gate | 22.2 | 21.7 | 20.7 | 26.4 | 23 ± 5 | 92 ± 20 |
| 025-400 | Bldg. 1010 Beam Stop 1 | 22.3 | NR | 20.7 | 23.8 | 22 ± 3 | 88 ± 12 |
| 034-403 | Bldg. 1008 Collimator 2 | 23.7 | 19.0 | 22.4 | NR | 22 ± 5 | 88 ± 20 |
| 034-405 | Bldg. 1008 Collimator 4 | 23.8 | 23.9 | 23.2 | NR | 22 ± 1 | 88 ± 3 |
| 044-400 | Bldg. 1006 | 24.4 | 22.9 | 23.4 | 26.9 | 24 ± 3 | 96 ± 12 |
| 045-400 | Bldg. 1005 | 22.3 | 23.8 | 23.1 | 28.4 | 24 ± 5 | 96 ± 20 |
| 088-400* | S6 | 66.8 | 65.9 | 68.0 | 68.1 | 67 ± 2 | 268 ± 8 |
| 054-400* | Bldg. 914 | 543.3 | 18.3 | 19.0 | NR | NC | NC |
| 075-000* | Control TLD (Avg.) | 20.5 | 20.5 | 11.3 | 12.8 | 16 ± 10 | 64 ± 40 |
| **Average of 34 Onsite TLDs** | | | | | | | 88 ± 7 |

Notes:
See Figure 8-1 for TLD locations.
Doses are not corrected for background level.
NC = Not Calculated (Average)
NP = TLD was not posted in the field.
NR = TLD dose not reported from the reader.
*TLD not included in onsite average. See explanation in text.

quent quarter measurements, and the loss of the TLD in the fourth quarter. This TLD had an extreme value for the first quarter (543.3 mrem) and is not an accurate representation of environmental dose in this area. After an investigation, it was determined that the high reading for this quarter may be attributable to the sky-shine phenomenon that occurs during the operation of the g-2 experiment. This experiment was operational only during the first quarter of 2000. The impact on dose from the g-2 experiment will be evaluated further in 2001. The second and third quarter measured doses of 18.3 and 19.0 (respectively) are representative of doses normally observed in the environment. Statistical comparison with data from previous years also indicates that the overall trend of environmental dose in this area was in the 17- to 20-mrem range for each quarter. The fourth quarter TLD was not recovered due to construction activities at the Booster Application Facility. It was decided that inclusion of this TLD in the sitewide average would skew the mean, thus making it difficult to interpret the data now and in the future.

The 088-400 TLD (S6) location had an extreme value in the data set that was so far removed from other external dose values that the chance probability of it being a valid member of the data set was remote. The proximity of TLD 088-400 to the radiologically posted Waste Management Facility is known to have contributed to high radiation dose for this TLD. Public access to radiological contamination areas is not permitted and authorized workers are routinely monitored. Therefore, the dose values for this TLD are reported in this SER but excluded from averaging because it was not an accurate representation of onsite environmental dose.

During 2000, the ambient dose was based on the average of the two LiF: Mg, Ti chips. Prior to 2000, all four chips (including the two $CaF_2$:Dy chips) were used to calculate dose. This change was made based on the results of a fade study (Harshaw Type 8807 Environmental Dosimeter [TLD Card 2211]) done on environmental dosimeters (EML-DOE 2000). The study concluded that the $CaF_2$ element showed much higher fading after 60 days of exposure in the field, and would therefore underestimate the dose. The LiF element fade was negligible for extended periods of exposure in the field. Normally, environmental TLDs are posted in the field for about 90 days but can be posted for extended periods, sometimes up to 120 days. Due to this change in monitoring, the environmental ambient dose for 2000 is about 20-30% higher than in previous years.

The average doses measured by the unshielded TLDs offsite were not significantly different from the average doses measured by the shielded TLDs. Therefore, it can be concluded that BNL operations had no measurable impact to the environment. The offsite TLD doses are summarized in Table 8-2.

#### 8.1.2 BUILDING 650 SUMP OUTFALL MONITORING

The Building 650 sump outfall is a localized area of radiologically contaminated soils approximately 800 feet northeast of Building 650. This area of contamination is being addressed under the Environmental Restoration Program (Operable Unit IV, Area of Concern [AOC] 6). Radionuclides identified in the AOC 6 soil include strontium-90, cesium-137, and isotopes of europium and plutonium.

The area around the sump is fenced and posted as a radiological area to prevent any unauthorized entry. Twenty-one TLDs are located within the sump area; and an additional four TLDs are located on the fence, one at each (north, east, west, and south) compass direction (see Figure 8-3). Additionally, two control TLDs are kept in a lead-shielded container as background TLDs for comparison.

The quarterly TLD doses measured in 2000 for the Building 650 Sump Outfall are given in Table 8-3. Consistent with previous years, the data show that the highest concentration of radionuclides was at the C4 location. The annual dose measured at C4 was 1.47 rem (15 mSv). The doses decrease south of the C4 grid towards D4 location and west grid at C3 location to 0.8 rem (8 mSv) and 0.7 rem (7 mSv), respectively. The dose measured at the A1 location was higher than expected for the first quarter because the TLD was found on the ground instead of the three foot (one meter) height above the ground. The dose was higher due to the shorter distance from the radiological source. The annual dose measured at the sump fence was similar to the control TLDs, demonstrating that the radia-

**Table 8-2. Offsite Ambient Radiation Measurements (CY 2000).**

| TLD # | Location | 1st Quarter (mrem) | 2nd Quarter (mrem) | 3rd Quarter (mrem) | 4th Quarter (mrem) | Average (mrem) | Annual Dose (mrem/year) |
|---|---|---|---|---|---|---|---|
| 000 – 401 | Private Property | 23.4 | 15.3 | 17.6 | NR | 19 ± 3 | 76 ± 12 |
| 000 – 402 | Private Property | 25.3 | 21.9 | 20.4 | 24.2 | 23 ± 2 | 92 ± 7 |
| 000 – 403 | Private Property | 22.3 | 26.3 | 19.7 | 42.0 | 28 ± 7 | 112 ± 28 |
| 000 – 408 | Private Property | NP | 19.3 | 20.2 | 21.5 | 20 ± 1 | 80 ± 4 |
| 000 – 411 | Private Property | NP | 19.6 | 20.6 | 23.1 | 21 ± 1 | 84 ± 4 |
| 000 – 412 | Private Property | NP | 21.2 | 25.6 | NR | 23 ± 2 | 92 ± 8 |
| 000 – 413 | Private Property | 26.9 | 17.1 | 20.2 | 22.6 | 22 ± 3 | 88 ± 12 |
| 000 – 414 | Suffolk County CD | 21.0 | 19.1 | 20.4 | 25.0 | 21 ± 4 | 88 ± 16 |
| 000 – 416 | Private Property | 18.0 | 19 | 17.9 | 19.6 | 19 ± 1 | 76 ± 4 |
| 000 – 417 | Private Property | NP | 12.6 | 21.6 | 19.7 | 18 ± 4 | 72 ± 12 |
| 000 – 418 | Private Property | 23.1 | 17.4 | 20.0 | 21.6 | 21 ± 2 | 84 ± 8 |
| 000 – 419 | Private Property | 18.3 | 19.5 | 19.6 | 22.4 | 20 ± 1 | 80 ± 4 |
| 000 – 420 | Smith Estate | 21.1 | 19.2 | 20.3 | 23.1 | 21 ± 1 | 84 ± 4 |
| 000 – 422 | Private Property | 19.3 | 20.6 | 22.9 | 22.5 | 21 ± 1 | 84 ± 4 |
| 000 – 424 | Mid. Isl. Game Farm | 21.9 | 19.5 | 20.5 | 23.7 | 21 ± 1 | 84 ± 4 |
| 000 – 425 | Calverton Nat. Cem. | 24.0 | 21.7 | 22.7 | 26.6 | 24 ± 2 | 96 ± 8 |
| 000 – 426 | Sportsmen's Club | 20.8 | 19.9 | 20.3 | 22.5 | 21 ± 1 | 84 ± 4 |
| 075- 000* | Control TLD (Avg.) | 20.5 | 20.5 | 11.3 | 12.8 | 16 ± 10 | 64 ± 40 |
| **Average of 17 Offsite TLDs** | | | | | | | 86 ± 9 |

Notes:
See Figure 8-2 for TLD locations.
NR = TLD dose Not Reported from the reader.
NP = TLD was Not Posted in the field.
*TLD not included in offsite average.

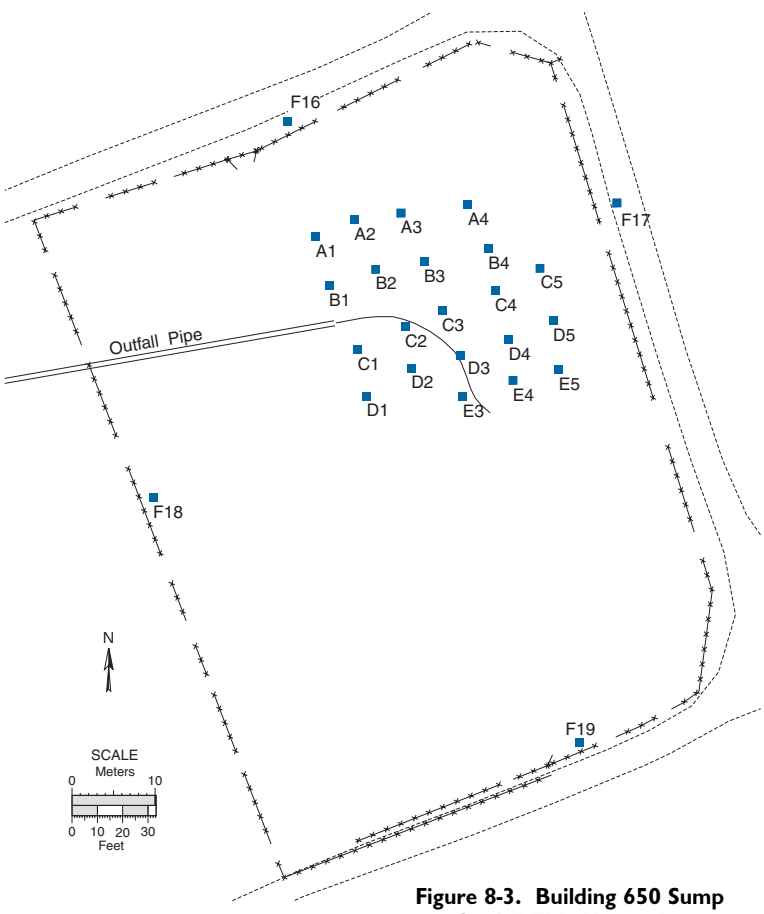


**Figure 8-3. Building 650 Sump Outfall TLD Network.**

tion field was localized to the immediate area. Entry into the sump outfall area was restricted to authorized personnel and therefore was not an exposure hazard to site workers or members of the public. Radiological dose to authorized personnel is monitored to ensure that their dose is below all DOE limits.

### 8.2 AIR EMISSIONS

The U.S. Environmental Protection Agency (EPA) has established radiation dose limits to members of the public from airborne radionuclide emissions released from DOE facilities. BNL operations are subject to the requirements of 40 CFR Part 61, Subpart H, "National Emission Standards for Hazardous Air Pollutants" (NESHAPs). This regulation specifies the monitoring and reporting requirements for various types of radionuclides and mandates that no member of the public receives a dose greater than 10 mrem (0.1 mSv) per year from exposure to airborne radionuclide emissions, other than radon, released from a DOE facility. The regulation also requires the DOE facility to submit an annual report to EPA that describes the atmospheric emissions for the preceding year and associated offsite impacts.

**Table 8-3. Building 650 Sump Outfall TLD Network (CY 2000).**

| TLD Location | 1st Quarter (mrem) | 2nd Quarter (mrem) | 3rd Quarter (mrem) | 4th Quarter (mrem) | Annual Dose (rem/year) |
|---|---|---|---|---|---|
| A1 | 189 ± 12 | 22 ± 2 | 23 ± 2 | 24 ± 2 | 0.26 ± 0.012 |
| A2 | 79 ± 5 | 81 ± 7 | 85 ± 6 | 79 ± 7 | 0.32 ± 0.013 |
| A3 | 28 ± 3 | 28 ± 3 | 31 ± 2 | 31 ± 3 | 0.12 ± 0.005 |
| A4 | 22 ± 2 | 24 ± 2 | 24 ± 2 | 22 ± 2 | 0.09 ± 0.004 |
| B1 | 20 ± 1 | 20 ± 1 | 21 ± 2 | 20 ± 2 | 0.08 ± 0.003 |
| B2 | 40 ± 3 | 42 ± 3 | 44 ± 3 | 42 ± 4 | 0.17 ± 0.007 |
| B3 | 86 ± 6 | 84 ± 7 | 94 ± 7 | 89 ± 7 | 0.35 ± 0.013 |
| B4 | 41 ± 3 | 42 ± 3 | 45 ± 3 | 43 ± 4 | 0.17 ± 0.007 |
| C1 | 24 ± 2 | 23 ± 2 | 22 ± 2 | 23 ± 3 | 0.09 ± 0.005 |
| C2 | 50 ± 3 | 51 ± 4 | 51 ± 5 | 52 ± 5 | 0.23 ± 0.009 |
| C3 | 177 ± 12 | 177 ± 13 | 180 ± 18 | 190 ± 16 | 0.72 ± 0.030 |
| C4 | 375 ± 29 | 361 ± 34 | 361 ± 46 | 371 ± 36 | 1.47 ± 0.073 |
| C5 | 34 ± 3 | 36 ± 2 | 35 ± 3 | 35 ± 4 | 0.14 ± 0.006 |
| D1 | 23 ± 2 | 21 ± 2 | 22 ± 3 | 22 ± 2 | 0.09 ± 0.004 |
| D2 | 32 ± 2 | 33 ± 3 | 32 ± 2 | 35 ± 4 | 0.13 ± 0.006 |
| D3 | 140 ± 10 | 132 ± 10 | 137 ± 15 | 161 ± 13 | 0.57 ± 0.024 |
| D4 | 194 ± 13 | 202 ± 16 | 195 ± 13 | 211 ± 21 | 0.82 ± 0.032 |
| D5 | 64 ± 4 | 63 ± 6 | 63 ± 6 | 68 ± 7 | 0.26 ± 0.012 |
| E3 | 103 ± 7 | 105 ± 8 | 101 ± 7 | 107 ± 9 | 0.42 ± 0.015 |
| E4 | 144 ± 10 | 147 ± 11 | 143 ± 10 | 165 ± 12 | 0.60 ± 0.021 |
| E5 | 107 ± 7 | 103 ± 7 | 108 ± 8 | 115 ± 10 | 0.44 ± 0.016 |
| F16 (Fence N) | 16 ± 1 | 15 ± 1 | 16 ± 1 | 16 ± 1 | 0.063 ± 0.002 |
| F19 (Fence S) | 15 ± 1 | 14 ± 1 | 15 ± 1 | 16 ± 2 | 0.060 ± 0.003 |
| F17 (Fence E) | 17 ± 1 | 16 ± 1 | 18 ± 2 | 15 ± 1 | 0.066 ± 0.003 |
| F18 (Fence W) | 17 ± 1 | 16 ± 1 | 17 ± 1 | 17 ± 1 | 0.068 ± 0.003 |
| Control TLD 1* | 13 ± 8 | 18 ± 2 | 19 ± 1 | 20 ± 2 | 0.069 ± 0.009 |
| Control TLD 2* | 18 ± 1 | 16 ± 1 | 18 ± 1 | 18 ± 2 | 0.070 ± 0.003 |

Notes:
See Figure 8-3 for TLD locations.
*Distant background locations used for comparison purposes.

### 8.2.1 AIR DISPERSION MODEL

Compliance with NESHAPs regulations is demonstrated through the use of EPA's CAP88-PC (Clean Air Act Assessment Package-1988) computer model program. The CAP88-PC computer code uses a Gaussian plume model equation to estimate the average dispersion of radionuclides released from elevated stacks or diffuse sources (EPA 1992). The program computes radionuclide concentrations in air, rates of deposition on ground surfaces, and concentrations in food (where applicable) to calculate a final value for projected dose at the specified distance from the release point. The program supplies both the calculated effective dose equivalent (EDE) to the maximally exposed individual (MEI) and the collective population dose within a 50-mile radius of the emission source. This model provides very conservative dose estimates 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 modeling programs are based on low-level environmental releases and chronic intakes. Input parameters used in the model include radionuclide type, emission rate in curies per year, stack parameters such as height and diameter, and emission exhaust velocity. Site-specific weather and population data were also used for the assessments. Weather data were supplied by measurements from BNL's meteorological tower. Data include wind speed, direction, frequency, and temperature. Population data for the surrounding area were based on a population survey by the Long Island Power Authority (LIPA 1999). Since visiting researchers and their families may reside at the onsite apartment area for extended periods of time, these residents were also included in the population file used for dose assessment.

#### 8.2.2 MAXIMALLY EXPOSED INDIVIDUAL

The MEI is defined as a hypothetical person who resides at the nearest location and has a lifestyle such that no other member of the public can receive a higher dose than this individual. The MEI is assumed to reside 24 hours a day, 365 days a year at the BNL boundary in the downwind direction, and consumes contaminated fish and deer during the year. In reality, it is a highly unlikely worst-case scenario that such a combination of maximized dose to any single individual would occur.

#### 8.2.3 DOSES FROM DIFFUSE AND NONPOINT SOURCES

The NESHAPs review process evaluates sources that have any potential to discharge radioactive air emissions at BNL. A number of Environmental Restoration Program operations were evaluated in 2000. Although environmental restoration activities are exempt from permitting requirements under the Comprehensive Environmental Response Compensation and Liability Act, activities with any potential to emit radioactive emissions were assessed for potential dose to the members of the public. The CAP88-PC modeling program is explicitly designed to model continuous airborne radioactive emissions that occur over the course of a single year and is not well suited for estimating short-term or acute releases. Given this limitation, the evaluations treated the potential emission sources as if they were continuous annual sources that do not end with the cessation of the environmental restoration activities. The assessment conclusions for the restoration activities are discussed below. With regard to BNL operations, diffuse sources and nonpoint sources that had a potential to emit radionuclides into the air in quantities that could cause an EDE in excess of 1% of the standard were evaluated, and a detailed discussion of these operations is provided in Chapter 4.

##### 8.2.3.1 CHEMICAL/ANIMAL AND GLASS HOLES PIT SOIL STOCKPILE #6B

The soil in stockpile #6B was generated during pit excavation. Stockpile #6B contained approximately 440 cubic yards (336 $m^3$) of soil removed from the bottom of several pits located in the animal/chemical pit area. Low concentrations of americum-241, cesium-137, potassium-40, neptunium-237, plutonium-239, plutonium-240, and thorium-232 and natural uranium isotopes were detected in the samples. Because there was a potential for radiologically/mercury-contaminated soil particles to become airborne during loading and shipping, a NESHAPs evaluation was conducted. Using the CAP88-PC model for dose and risk assessment, the effective dose equivalent to the MEI from these activities was estimated at 6.07E-03 mrem/year (6.07E-02 μSv/yr).

##### 8.2.3.2 WASTE CONCENTRATION FACILITY SOIL EVACUATION

Soils were removed from the Waste Concentration Facility yard (Building 811) as part of the underground storage tank and piping removal project. This activity had a release inventory of radionuclides in the soil of cesium-137 (464 pCi/g [17.2 Bq/g]) and strontium-90 (454 pCi/g [16.8 Bq/g]). Using the CAP88-PC model, an effective dose equivalent of 8.52E-03 mrem/year (8.52E-02 μSv/yr) to the MEI was estimated.

##### 8.2.3.3 BROOKHAVEN GRAPHITE RESEARCH REACTOR DUCT REMOVAL

Sections of the Brookhaven Graphite Research Reactor (BGRR) aboveground duct were sectioned and removed. Radiological samples were taken from the interior surface of the ductwork to determine the type and amounts of contamination present. A fixative was used to contain any loose contamination and the duct opening was capped and sealed to prevent the spread of contamination. Using site-specific meteorological data and current population data, the EDE to the MEI estimated with the CAP-88-PC model was 1.5E-04 mrem/year (1.5E-04 μSv/yr).

##### 8.2.3.4 AREA OF CONCERN 16 SOIL REMOVAL ACTION

This environmental restoration action involved the excavation of landscape soil contaminated with low levels of cesium-137 in each of the six Areas of Concern to a depth of approximately one foot (0.36m). Using the CAP-88 model, along with site-specific meteorological data and current population data, the EDE to the MEI was estimated to be 3.66E-02 mrem/year (3.66E-01 μSv/yr).

##### 8.2.3.5 RADIOACTIVE WASTEWATER PROCESSING OPERATIONS

During a process evaluation of radioactive wastewater processing operations associated with the Waste Concentration Facility in

Building 811, waste transfer operations in Building 810, and the Evaporator Facility in Building 802B, a recommendation was made to conduct a NESHAPs evaluation of sources that have the potential to release small amounts of radioactive air emissions that are not directed to the High Flux Beam Reactor stack. Included among the sources evaluated were vent pipes for the four aboveground wastewater storage tanks in Building 811, vent pipes for a 15-gallon (57-liter) condensate storage tank, a 5000-gallon (18,925-liter) tritiated water tank in Building 802B, and potential fugitive emissions from leaks in pumps and pipe valves in the wastewater transfer lines connecting the three buildings. The potential airborne source term was based on the information provided in the BNL Process Assessment Form and emission factors from 40 CFR 61, Appendix D. The CAP88-PC model provided a conservative estimate of the EDE to the MEI of 1.76E-03 mrem/year (1.76E-02 µSv/yr).

#### 8.2.4 AIRBORNE PATHWAY - EFFECTIVE DOSE EQUIVALENT CALCULATIONS

In 2000, the Brookhaven Medical Research Reactor (BMRR) air emissions were monitored continuously. Because the potential for air emission was above 0.1 mrem from the air pathway, continuous monitoring is required. The EDE to the MEI from all radiological airborne emission sources combined was 0.18 mrem (1.8 µSv). Argon-41 (gaseous, half-life=1.8 hours) released from the BMRR was the only contributor of this dose. By comparison, this was less than 2% of the EPA airborne dose limit of 10 mrem (0.1 mSv) and was statistically insignificant compared to the dose received annually from natural background radiation. From a dose perspective, a person living in the state of Colorado would receive 900 mrem per year from natural sources and one living in Spokane, Washington about 1,400 mrem year (NCRP 1987). In comparison, Long Island's natural background dose is relatively low at 300 mrem/year. The estimated doses to the maximally exposed individual for radionuclides released from all potential sources of airborne emissions are given in Table 8-4.

**Table 8-4. Effective Dose Equivalent to the Maximally Exposed Individual From Airborne Emission Sources (CY 2000).**

| Building | Facility or Process | MEI Dose (mrem) |
|---|---|---|
| 491 | BMRR | 1.8E-01 |
| 750 | HFBR | 2.1E-05 |
| 931 | BLIP | 2.2E-03 |
| 801 | Target Processing Lab | 3.1E-07 |
| 802B | Evaporator Facility | 1.9E-05 |
| — | RHIC | ND |
| 942 | AGS Booster | ND[a] |
| 490 | Radiation Therapy Facility | 4.5E-07[b] |
| 820 | Accelerator Test Facility | ND[c] |
| 938 | Radiation Effects Facility/ Neutral Beam Test Facility | ND[d] |
| 510 | Calorimeter Enclosure | ND |
| 463 | Biology Facility | 5.3E-09[e] |
| 555 | Chemistry Facility | 8.1E-11[e] |
| 830 | Environmental & Waste Mgmt. | 5.6E-12[e] |
| 490D | Environmental Biology& Ins. | ND |
| 490 | Medical Research Center | ND |
| 703 | Analytical Laboratory | ND |
| **Total from BNL Operations** | | 0.18 mrem |
| **EPA Limit** | | 10.00 mrem |

Notes:
"Dose" as used in this table means effective dose equivalent.
ND = No Dose (facility not operational or no source in 2000).
[a] Booster ventilation system prevents air release through continuous air recirculation.
[b] Based on conservative engineering calulations.
[c] This has become a zero-release facility since original permit application.
[d] This facility is no longer in use, it produces no radioactive air emissions.
[e] All doses based on emissions calculated using 40 CFR 61, Appendix D methodology.

### 8.3 FISH CONSUMPTION - EFFECTIVE DOSE EQUIVALENT CALCULATIONS

Calculations were made to determine the potential dose impact to the MEI from consuming fish taken exclusively from the Peconic River. As discussed in Chapter 6, fish from the Peconic River and Peconic-fed water bodies continue to be analyzed for radiological content because of known historical radionuclide discharges from the BNL Sewage Treatment Plant. These releases occurred primarily in the 1950s and 1960s. In 2000, fish samples collected from the Peconic River were analyzed for gamma-emitting radionuclides; only potassium-40 and cesium-137 were above the minimum detection limit. The maximum concentration, 1.30 ± 0.16 pCi/g (48 ± 5.9 mBq/g), wet weight of cesium-137, was detected in a composite sample of brown bullhead, a local species of catfish. The cesium-137 concentration in pumpkinseed (a local panfish) from the same location, analyzed as a composite sample, was 1.19 ± 0.14 pCi/g (44 ± 5.2 mBq/g) wet weight. Chain pickerel had a

concentration of 1.13 ± 0.17 pCi/g (42 ± 6.3 mBq/g) of cesium-137. The average concentration of 1.20 ± 0.08 pCi/g (44 ± 2.9 mBq/g) of cesium-137 for all three species of fish was used in dose calculations. By comparison, the concentration of potassium-40, another beta/gamma emitting radionuclide, found in a banana, about 3 pCi/g (111 mBq/g), is higher than the cesium-137 found in the fish collected from the Peconic River.

For dose evaluation, a MEI was assumed to eat 15 pounds of fish during the course of the year (NYSDOH 1996). Exclusive consumption of brown bullhead, pumpkinseed, and chain pickerel at the rate and concentration given above would result in an EDE of 0.42 mrem (4.2 μSv) due to cesium-137 concentrations. By comparison, the average individual EDE caused by ingestion of naturally occurring radionuclides in the U.S. is about 40 mrem (400 μSv) per year (NCRP 1987). There were no radionuclides detected in shellfish, aquatic vegetation, marine waters, and sediments above the minimum detection limit.

### 8.4 DEER MEAT CONSUMPTION - EFFECTIVE DOSE EQUIVALENT CALCULATIONS

As discussed in Chapter 6, measurements were made of flesh and liver samples collected from deer taken on BNL property as well as from offsite locations. Cesium-137 was detected in flesh samples from onsite deer at concentrations lower than those found in offsite deer. The onsite average concentration found in flesh samples was 1.49 ± 0.27 pCi/g (55 ± 9.9 mBq/g) wet weight. In comparison, the offsite deer flesh sample averaged 1.97 ± 0.34 pCi/g (73 ± 12.6 mBq/g) wet weight of cesium-137. While onsite hunting was not permitted, there are no physical barriers preventing deer from migrating beyond the site boundary. It was, therefore, conceivable that hunters could occasionally take a deer that resides predominantly on the BNL site.

In March 1999, the New York State Department of Health (NYSDOH) Bureau of Environmental Radiation Protection issued a report examining the possible dose impacts to members of the public who consume deer that have grazed extensively on the BNL site (NYSDOH 1999). In the NYSDOH report, a 10mrem/year (100 μSv/year) dose was used as the limit for deer meat consumption. The annual consumption rate of venison was estimated using the EPA's Exposure Factors Handbook, which gives the average intake of game meat (for those who consume it) as approximately 1.1 grams per day per kilogram of body weight (0.018 ounces per day per pound of body weight) (EPA 1996). For a 154 pound (70 kilogram) individual, this corresponds to about 64 pounds (28 kilograms) of venison consumed per year. The same assumptions have been adopted for this report.

The potential dose from deer meat consumption was calculated using the arithmetic average of the cesium-137 concentrations measured in flesh samples collected onsite and one mile radius around the laboratory. In dose calculations, a wet weight average concentration (i.e., the concentration in the flesh sample prior to drying for analysis) of 1.85 ± 0.33 pCi/g (68 ± 12 mBq/g) was used. Under the stated assumptions, the committed EDE due to consumption of 64 pounds (28 kilograms) of local deer meat would be equal to 2.68 mrem (27 μSv) per year. This is 27% of the health advisory limit of 10 mrem (0.1 mSv) established by the NYSDOH. By comparison, the average EDE from eating foods that contain naturally occurring radionuclides is 40 mrem (0.4 mSv) per year (NCRP 1987).

### 8.5 COLLECTIVE TOTAL EFFECTIVE DOSE EQUIVALENT

Collective total effective dose equivalent (TEDE), a value used to estimate potential health risks to a population, is the summation of the calculated EDE for each individual multiplied by the number of individuals in the population being considered.

Assuming that the total number of individuals who routinely consume fish taken from portions of the Peconic River near the BNL site was 625, the collective TEDE from this pathway was 263 person-mrem (2.6 person-mSv). This value was based on the maximum fish concentrations discussed in Section 8.3 above. In comparison, the collective TEDE to the same population from consumption of naturally occurring radionuclides in food was 25,000 person-mrem (250 person-mSv) annually.

Since onsite deer hunting was prohibited, the individual dose estimate from meat consumption calculated in Section 8.4 was based on the average cesium-137 concentrations. Deer moving beyond BNL boundaries can be legally hunted and consumed, resulting

in collective dose. However, the number of people hunting deer or consuming deer meat taken within a one-mile radius of BNL was not tracked; consequently, the collective dose from deer meat consumption was not calculated.

For the air exposure pathway, the CAP88-PC computer model provides collective TEDE estimates using population data for the area within a 50-mile radius of the BNL site. The population data are broken down into the number of people living within each of the 16 compass sectors at 10-mile radial intervals. Again, argon-41 emitted from the BMRR was the largest contributor to the total collective committed effective dose equivalent of 6,437 person-mrem (64 person-mSv). This constituted 99% of the total collective dose resulting from BNL operations projected for the population within a 50-mile radius of BNL.

### 8.6 DOSES TO AQUATIC AND TERRESTRIAL BIOTA

DOE has developed draft screening methods to estimate radiological doses to aquatic animals, terrestrial plants, and terrestrial animals using the environmental surveillance data. These methods can be used to show compliance with the requirements for protection of biota in the DOE Order 5400.1 (1988), *General Environmental Protection Program*, 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 absorbed dose to aquatic animals and terrestrial plants should not exceed 1 rad/day (10 mGy/day), and 0.1 rad/day (1 mGy/day) to terrestrial animals from exposure to radiation or radioactive material released into the environment.

The average concentrations of radionuclides measured at the BNL site were used to show compliance with these proposed limits. The average concentration (0.21 pCi/g or 7.7 mBq/g) of cesium-137 was analyzed in soil samples collected onsite. The draft DOE Technical Standard ENVR–0011 (DOE 2000) was used to evaluate the dose impact to the terrestrial animals. The sum fraction of radionuclides in soil was 1.01E-02 and passed the criteria using the Biota Concentration Guide calculator given in the standard. The site-specific cobalt-60 (0.07 pCi/g or 2.6 mBq/g) and cesium-137 (0.16 pCi/g or 5.9 mBq/g) concentrations in sediments were used to calculate dose impacts to the aquatic animals. The sum fraction of radionuclides was calculated to be 3.77E-03 in this media. The total sum of the fractions was less than one, and therefore passed the screening criteria for dose to the biota. It can be concluded from the biota screening methods that there was no radiological dose to aquatic animals, terrestrial plants and terrestrial animals from BNL operations. Additional information on the body burden in deer is provided in Chapter 6, Section 6.3.1.

### 8.7 SUMMARY AND CONCLUSION

Calculations of EDE from all BNL facilities that have the potential to release radionuclides to the atmosphere indicated that radiological doses attributable to Laboratory operations were well below the limits established by federal regulations (see Table 8-5). Direct measurement of external radiation levels by TLDs confirmed that exposure rates at the site boundary were consistent with background levels. No dose was calculated for drinking water since the majority of homes have been hooked up to public water supply, and there are no radionuclide plumes above the drinking water standards beyond the BNL boundary. As some residents in the hookup area chose not to accept DOE's water hookup offer, DOE began identifying and contacting these property owners in the summer of 2000 to offer free yearly testing of their water supply.

The EDE calculations presented in this chapter were based on the MEI for each scenario using the stated assumptions. Given this, it is unlikely that any single person could receive a radiological dose equal to the sum of these individual pathways. The hypothetical MEI, defined as residing at the northeast boundary of BNL, breathing the air, and consuming 15 pounds of contaminated fish and 64 pounds of contaminated deer meat from onsite sources, would receive 3.28 mrem/year (32.8 μSv/year) total effective dose equivalent. This highly unlikely worst-case scenario was calculated to show that the dose from all pathways would still be less than 4% of 100 mrem/year (1 mSv/year) dose limit set by DOE for members of the general public, and is insignificant when compared to the average annual dose of 360 mrem/year (3.6 mSv/year) (NCRP 1987) from cosmic, terrestrial and radon sources. These MEI doses

**Table 8-5. Summary of Potential Dose from All Environmental Pathways (CY2000).**

| Matrix | Pathway | Primary Contributing Radionuclide | Maximally Exposed Individual EDE (mrem) | Regulatory Pathway Limit (mrem) | Collective EDE (person-mrem) |
|---|---|---|---|---|---|
| Air | Inhalation | Ar-41 | 0.18 | 10 | 6,437 |
| Food | Fish[1] | Cs-137 | 0.42 | SNS | 263 |
| | Deer Meat[2] | Cs-137 | 2.68 | SNS | NA |
| Water | Drinking Water[3] | NA | NA | NA | NA |

Notes:
EDE = Effective Dose Equivalent.
NA = Not Applicable
SNS = Standard Not Specified
(1) Fish dose calculation is based on measured Cs-137 concentration only.
(2) Deer dose is based on the average deer concentration in samples collected onsite and one mile radius around BNL. Calculation assumes a consumption rate of 64 lbs/yr.
(3) No drinking water dose projected following connnection of public water supply to homes adjacent to BNL.

demonstrate that in 2000 there was minimal radiological dose impact above the natural background to members of the public and the environment from BNL operations.

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Chapter 9

# Quality Assurance

Quality assurance is an integral part of every function at BNL. A comprehensive program is in place to ensure that all environmental monitoring data meet quality assurance and quality control requirements. Samples are collected and analyzed in accordance with standard operating procedures. These procedures are designed to make certain that samples are representative and data are reliable and defensible. Quality control in the analytical laboratories is maintained through daily instrument calibration, efficiency and background checks, and testing for precision and accuracy. Data is verified and validated before it is used to support decision making.

BNL uses the onsite Analytical Services Laboratory and four offsite contractor laboratories to analyze environmental samples. All analytical laboratories are New York State certified for the tests they perform for BNL, and are subject to oversight that includes state and national performance evaluation testing, review of quality assurance programs, and audits.

The two primary laboratories reporting radiological analytical data scored between 89% and 95% satisfactory results in both state and federal performance evaluation programs. In nonradiological performance evaluation testing, each laboratory received a satisfactory rating of over 92% in the 2000 New York State Environmental Laboratory Approval Program evaluations. The BNL Quality Assurance/Quality Control Program ensures that all analytical data reported for the *Site Environmental Report 2000* are reliable and of high quality.

### 9.1 QUALITY ASSURANCE/QUALITY CONTROL PROGRAM ELEMENTS

As required by DOE Order 5400.1 (1988), *General Environmental Protection Program*, BNL has established a Quality Assurance/Quality Control (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 414.1 (1998), *Quality Assurance*. Responsibility for quality at BNL starts with the Laboratory Director and extends throughout the entire organization. The BNL quality management system defines quality requirements, establishes an assessment process to evaluate performance, and provides technical assistance from quality professionals.

For environmental monitoring, QA is defined as an integrated system of management activities that includes 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 environmental monitoring standard operating procedures (designated EM-SOPs) (BNL 1999a). Staff who must follow these procedures and plans are required either to sign off on the document or receive training.

The ultimate goal of the environmental monitoring and analysis QA/QC program is ensuring that results are representative and defensible, and that data are of the type and quality needed to verify protection of the environment. To achieve this, monitoring and analytical activities are planned with the end use in mind. Figure 9-1 depicts the flow of the QA/QC elements of BNL's Environmental Monitoring Program, and indicates the section of this chapter that discusses the element in more detail. First, BNL environmental scientists and engineers determine sampling requirements using the U.S. Environmental Protection Agency (EPA) Data Quality Objective (or equivalent) process. During this process, the type, amount and quality of data needed to support decision making, legal requirements, stakeholder concerns, and technical information are considered. Next, an environmental monitoring plan or project-specific sampling plan is prepared that specifies the location, frequency, type of sample, analytical methods to be used, and a schedule. These plans or the standard operating procedures also specify data acceptance criteria. Contracts with offsite analytical laboratories are established as necessary. Detailed standard operating procedures guide sampling technicians on proper sample collection, preservation, and handling requirements. Field quality control samples are prepared as necessary. Samples are analyzed in the field, or subsequently analyzed at certified laboratories, in accordance with established procedures. The results are then validated and/or verified again in accordance with a set of 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 the annual Site Environmental Report. Tables and figures on QA/QC results for calendar year 2000 are presented in this chapter and in Appendix F. Most of the data contained in this report are condensed and summarized from a separate document, *Year 2000 ASL Quality Assurance Report* (Scarpitta and Heotis 2001).

### 9.2 SAMPLE COLLECTION AND HANDLING

In 2000, environmental monitoring samples were collected as specified by procedures, the *BNL Environmental Monitoring Plan* (BNL 2000), the *Groundwater Monitoring Program QA Project Plan* (BNL 1999b), and/or project-specific work plans, as applicable. For example, the BNL Groundwater Monitoring Program QA Project Plan describes the QA program and QC requirements 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/database procedures.

BNL has prepared sampling standard operating procedures for all environmental media, including groundwater, surface water, soil, sediment, air, flora and fauna (BNL

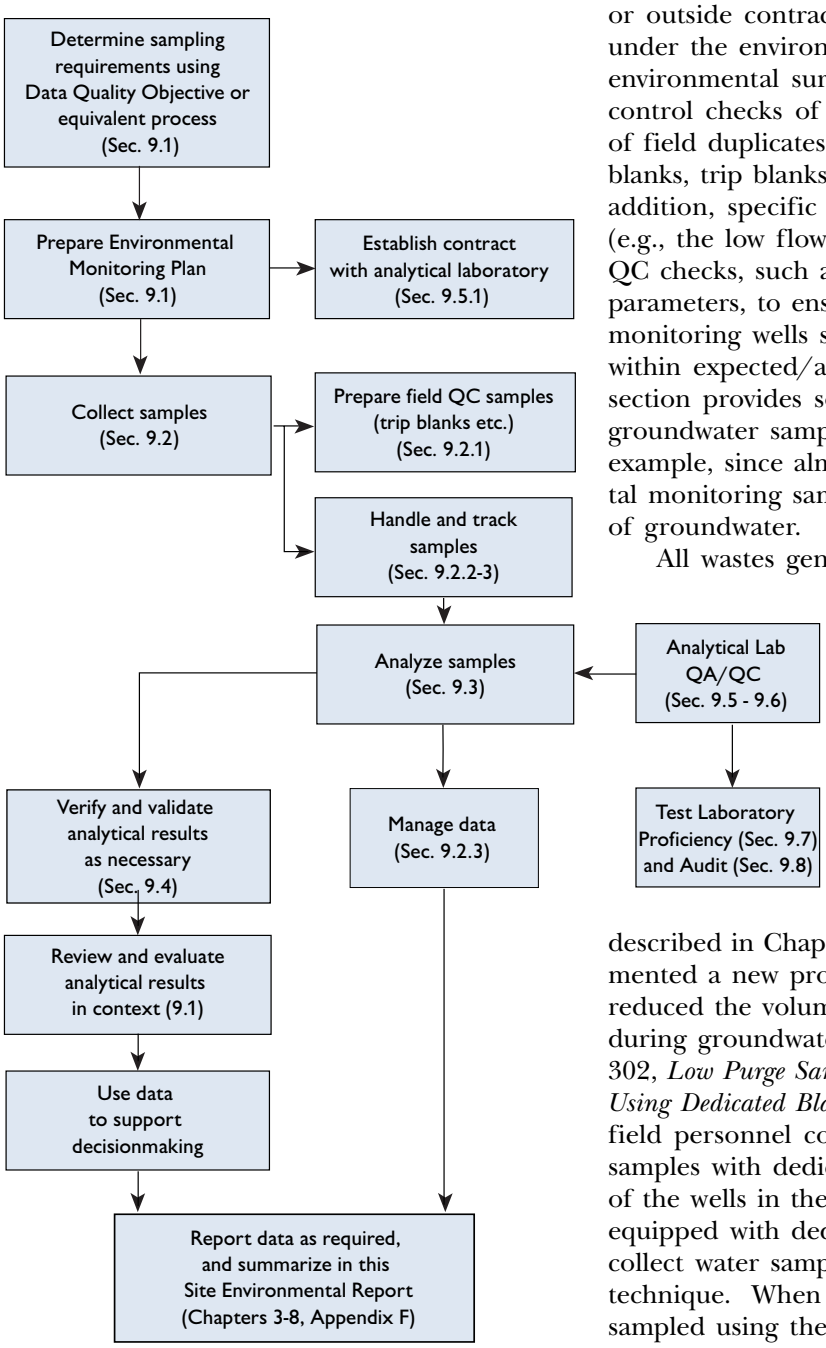


**Figure 9-1. Flow of Environmental Monitoring QA/QC Program Elements.**

1999a). 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 employees or outside contractors, whether collected under the environmental restoration or environmental surveillance programs. Quality control checks of sampling include collection of field duplicates, matrix spike samples, field blanks, trip blanks, and equipment blanks. In addition, specific sampling methodologies (e.g., the low flow sampling technique) include QC checks, such as field analysis of stability parameters, to ensure proper purging of monitoring wells so that all parameters are within expected/acceptable limits. This section provides some specific information on groundwater sampling procedures as an example, since almost half of all environmental monitoring samples collected for BNL are of groundwater.

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. In 1999, BNL implemented a new procedure that dramatically reduced the volume of wastewater generated during groundwater well sampling. EM-SOP-302, *Low Purge Sampling of Monitoring Wells Using Dedicated Bladder Pumps*, was followed by field personnel collecting groundwater samples with dedicated pumps installed. Most of the wells in the monitoring program are equipped with dedicated pumps designed to collect water samples using the low flow technique. When a well was designated to be sampled using the low flow technique, but a dedicated pump had not been installed, the procedures outlined in EM-SOP-307, *Low Purge Sampling of Monitoring Wells Using Non-dedicated Pumps*, was used. As mentioned in the 1999 Site Environmental Report, the only exception was for the AOC 29 High Flux Beam Reactor Project, where procedures outlined in the *Natural Attenuation Monitoring Work Plan for the HFBR Tritium Plume* (BNL 1998) were followed until April 2000. From April 2000 on, the low flow techniques described in EM-SOP-302 and

307 were used for sample collection. This change to low flow sampling significantly reduced the amount of purge water waste that had to be collected for disposal as radiological waste. An example of the volume reduction achieved is the routine sampling of Well 095-48. Using the sampling technique that involved purging three volumes of the well casing prior to sampling, approximately 200 gallons of tritiated purge wastewater were being collected per month. Using the low flow sampling technique, this was reduced to approximately 5 gallons per month.

### 9.2.1 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 selection of specific field QC samples and minimum requirements for use in the environmental monitoring program are provided in EM-SOP-200, *Collection and Frequency of Field Quality Control Samples*.

Equipment (rinsate) blanks and trip blanks were generally collected for all media except air and flora and fauna. An equipment blank is a volume of solution used to rinse a sampling tool before sample collection. The rinsate is collected to demonstrate that the sampling tool was not contaminated. A trip blank is provided with each shipping container of samples to be analyzed for VOCs. Analytical results from trip blanks are used to determine whether the sample bottle was contaminated during shipment from the manufacturer, bottle storage, shipment to the laboratory, or during analysis at the laboratory. For the Groundwater Monitoring Program, trip blanks consist of an aliquot of distilled water that is sealed in a sample bottle, prepared either by the analytical laboratory prior to shipping the sample bottles to BNL, or by field sampling personnel. Under the groundwater monitoring program, trip blanks were included with all shipments of aqueous samples for volatile organic analyses.

Field blanks were collected to evaluate potential cross-contamination of samples during sample collection. For the Groundwater Monitoring Program, the frequency of collection was one field blank for every twenty samples, or one per sampling round, whichever was more frequent. On any given day, the fields blank were analyzed for the same parameters as the groundwater samples.

Equipment blank samples were collected, as needed, to verify the effectiveness of the decontamination procedures on nondedicated or re-usable sampling equipment. For the Groundwater Monitoring Program, equipment blanks were collected from the final rinse water generated during decontamination using laboratory grade water. When equipment blanks were needed, these QC samples were collected in accordance with EM-SOP-200.

#### 9.2.1.1 FIELD QUALITY CONTROL SAMPLE RESULTS

Contaminants in trip, field, and equipment blanks included methylene chloride, acetone, toluene, and phthalate esters. When these compounds were detected, validation and/or verification procedures were used to "qualify" the data, as described in procedures EM-SOP-203 through 211 (see Section 9.4). The results from blank samples collected during 2000 did not indicate any significant impact to the quality of groundwater results. Typically, the only compounds detected in the blanks were toluene, chloroform, methylene chloride, and acetone.

Field duplicate samples were analyzed to check the reproducibility of sampling and analytical results. For the groundwater monitoring program, duplicates were collected for 5% of the total number of samples collected for a project per sampling round. Table F-1 in Appendix F summarizes the number of field duplicate samples collected during 2000 that were acceptable for input into the Environmental Information Management System database. Field duplicate acceptability was based on EPA Region II guidelines (EPA 1996).

The relative percent differences for concentrations above the contract reporting limits was required to be below 20% for the duplicate. (See Section 9.6.2 for more information on the relative percent difference statistic.) While individual compounds did not meet the 20% Relative Percent Difference limit on several occasions, the overall list of parameters analyzed for a given sample did meet the 20% requirement. This indicated that the field sampling personnel and the laboratories were performing the sampling analyses at a consistently high level of quality.

Matrix spike and matrix spike duplicates for organic analyses were performed in order to determine if the sample matrix adversely affected the sample analysis. Matrix spikes are used to evaluate the effect of the sample matrix on the accuracy of a specific analysis. Matrix spike duplicates are used to evaluate the precision of a specific analysis. They were performed at a rate of approximately one per twenty samples collected per project. For groundwater samples no significant interferences were observed.

Several results for media other than groundwater were considered suspect after evaluating field quality control sample results. These instances are discussed in detail in Chapters 3-8.

#### 9.2.2 FIELD SAMPLE HANDLING

In order to ensure the integrity of samples, chain-of-custody was maintained and documented for all samples collected. A sample or evidence file is considered to be in the custody of a person if any of the following rules of custody are met: (a) the person has physical possession of the sample or file, (b) the sample or file is in view of the person after being in possession, (c) the sample or file is placed in a secure location by the custody holder, or (d) the sample or file is in a designated secure area. These procedures are outlined in EM-SOP-109, *Chain-of-Custody Procedure*. All environmental monitoring samples maintained a valid chain-of-custody from the time of sample collection through sample disposal.

##### 9.2.2.1 FIELD SAMPLE CUSTODY AND DOCUMENTATION REQUIREMENTS

The field sampling team leader was responsible for the care and custody of the samples collected until they were transferred to a sample receiving group or an analytical laboratory. Samples requiring refrigeration were placed immediately into a refrigerator or a cooler with cooling media, and kept under custody rules. The sampling team member who maintained custody of the samples signed the chain-of-custody form upon relinquishing custody of the samples. The laboratory or group receiving the samples would then sign the chain-of-custody accepting custody of the samples.

The sampling team was also required to maintain a field logbook. The field logbook is a bound, weatherproof logbook filled out at the time of sample collection. It contains sample designation, sample collection time, sample description, sample collection method, daily weather, field measurements, and other site-specific observations, as appropriate.

##### 9.2.2.2 SAMPLE PRESERVATION AND SHIPMENT

Samples shipped to offsite laboratories were managed as follows. Prior to sample collection, the sampling team prepared all bottle labels and affixed them to the appropriate containers, as defined in the QA Program Plan or applicable standard operating procedures. Appropriate preservatives were added to the containers prior to sample collection or immediately after collection, and/or samples were refrigerated.

After sample collection by BNL or contractor personnel, sample preservation was maintained as required throughout shipping. If samples were sent via commercial carrier, a bill-of-lading was used. Chain-of-custody seals placed on the shipping containers prevented the container from being opened without breaking the seal, ensuring that custody was maintained during shipment.

#### 9.2.3 SAMPLE TRACKING AND DATA MANAGEMENT

##### 9.2.3.1 SAMPLE TRACKING

The majority of Environmental Monitoring Program samples and analytical results were tracked in the Environmental Information Management System. Tracking was initiated when a sample was recorded on a chain-of-custody form. Copies of the chain-of-custody and supplemental forms were provided to the project manager or the sample coordinator and forwarded to the data coordinator for entry into the Environmental Information Management System. Each analytical laboratory also maintains its own internal sampling tracking system.

##### 9.2.3.2 DATA MANAGEMENT PROCEDURES

Data management procedures have been developed and implemented to govern tracking, validation, verification, and distribution of the analytical data. When samples were shipped to an analytical laboratory, chain-of-custody information was entered into the Environmental Information Management System. Following sample analysis, the laboratory provided the results to the project manager or their designee, and, when appli-

cable, the validation subcontractor in accordance with its contract with BNL.

#### 9.2.3.3 DISTRIBUTION OF ANALYTICAL DATA

Once data was entered into the Environmental Information Management System, reports were generated by one of two means. Project personnel and DOE-Brookhaven Area Office staff had a data query tool that allows access to all analytical sample results and print reports. If a project required a special format for the report, the data management group was contacted and a special report was designed and printed.

### 9.3 SAMPLE ANALYSIS

Environmental samples were analyzed either by the onsite laboratory (the BNL Analytical Services Lab [ASL]), or by one of four contractor laboratories. BNL procured and maintained contracts with the following offsite laboratories:

- General Engineering Lab (GEL) in Charleston, South Carolina, for radiological and nonradiological analytes;
- H2M Lab in Melville, New York, for nonradiological analytes;
- Severn-Trent Lab (STL), in Monroe, Connecticut and St Louis, Missouri, for radiological and nonradiological analytes; and
- Chemtex Lab in Port Arthur, Texas, for select nonradiological analytes.

All samples were analyzed according to EPA-approved methods, if such methods exist. If no EPA-approved methods exist, standard industry methods were used if BNL personnel had approved them.

In addition, sampling technicians performed field analyses of certain wastewaters for residual chlorine and pH.

### 9.4 VERIFICATION AND VALIDATION OF ANALYTICAL RESULTS

Environmental monitoring data underwent data verification and/or validation, in accordance with established procedures. For example, the procedures used for verification and validation of analytical results in the Groundwater Monitoring Program are contained in EM-SOP-203 through 211. Data packages not subject to validation were verified by environmental program staff, as per BNL procedures.

The following criteria cause data to be rejected during the data verification/validation process:

- *Holding time missed.* The analysis was not initiated or the sample was not extracted within the time frame required by EPA or by the contract.
- *Incorrect test method.* The analysis was not performed according to a method required by the contract.
- *Poor recovery*. The compounds or radioisotopes added to the sample prior to laboratory processing were not recovered at the recovery ratio required by the contract.
- *Insufficient QA/QC data.* Supporting data received from the analytical laboratory were insufficient to allow validation of results.
- *Incorrect MDL.* The laboratory reported extremely low levels of analytes as "less than minimum detectable," but the contractually required limit was not used.
- *Invalid chain-of-custody.* There was a failure to maintain proper custody of samples, as documented on chain-of-custody forms.
- *Instrument failure.* The instrument did not perform correctly or was broken.
- *Preservation requirements*. The requirements identified by the specific analytical method were not met and properly documented.

The data verifier is responsible for checking for the most common errors associated with analytical data. These include holding time violations, unacceptable chemical recovery of internal standards or tracers, use of an improper analytical method, contamination of samples from outside sources (e.g., trip blanks analyzed with samples according to the correct method and no analytes detected), matrix interferences, and completeness of the data package and reports. The data validator is responsible for the same things as a verifier, as well as checking for less common errors, such as calibration not conducted in accordance with method requirements, internal standard errors, transcription errors, and calculation errors.

For samples analyzed by the onsite ASL, the QA officer was responsible for verifying that all analytical batches fulfilled internal QA/QC acceptance criteria. The criteria include: (a) precision, (b) accuracy, (c) recovery, (d) instrument background checks, and (e) stable instrument efficiency performance. All QA/QC data were reviewed before ASL results were reported. These criteria are fully described in ASL's *QA Program Plan* issued in May 1999

(BNL 1999c). The data verifier or validator ensured that data complied with the contract specifications before the data was accepted and reported.

When a set of analytical results was received from an *offsite* laboratory, a certain percentage of results were given to either a data verifier or a data validator who was a subject matter expert in either radiological analyses or analytical chemistry. Nonradiological data analyzed offsite were verified and validated using EPA Contract Laboratory Program guidelines (EPA 1992, 1996). Radiological packages were verified and validated using BNL and DOE guidance documents (BNL 1997, DOE 1994).

The amount of data that underwent either the verification or validation processes was dependent on the Data Quality Objectives for each specific project and environmental media. Data from some projects, such as long term groundwater monitoring, may have undergone only verification, while data from projects such as initial investigations underwent validation ranging from 20% of the results up to 100% of the results. Results of verifications (including data qualifiers discussed in Section 9.2.1.1) were added to the Environmental Information Management System.

## 9.5 ANALYTICAL LABORATORY QA/QC

### 9.5.1 CONTRACTOR LABORATORY SELECTION

The process of selecting contractor laboratories involves evaluating past performance evaluation testing results, pre-selection bidding, post selection auditing, and adherence to their own QA/QC programs. Once the contract has been awarded, the laboratory must follow the quality assurance requirements, and analytical and quality control requirements in the BNL statement of work. Routine QC procedures followed by laboratories include daily instrument calibrations, efficiency and background checks, and standard tests for precision and accuracy, as discussed in Sections 9.6.1.2. All analytical laboratories used by BNL are New York State Department of Health (NYSDOH) certified for the analytes they test for BNL. They are also subject to performance evaluation testing (Section 9.7) and audits (Section 9.8).

Sample analyses for environmental restoration samples were performed by GEL and STL. Environmental surveillance data were analyzed by either ASL or H2M Labs, Inc.

The onsite BNL analytical laboratory, ASL, performs approximately 5,000 radiological and nonradiological (chemical) analyses per year on environmental samples in support of both environmental monitoring and facility operations. The ASL is certified by NYSDOH for tritium, gross alpha/beta, and gamma in potable and nonpotable water analyses in several matrices, all of which are approved EPA methods.

Samples sent offsite for radiological analyses were those requiring either EPA methods or DOE standard methods that ASL did not perform. Examples are strontium-90 and actinide analyses in soil, vegetation, animal tissue, and water. As discussed in Chapter 3, samples used to verify compliance to permitting requirements were generally analyzed by an offsite laboratory.

Samples requiring semivolatile organic analyses and toxicity characteristic leachate procedure (TCLP) samples were sent offsite. In addition, when demand exceeded ASL capacity, some strontium-90, metals, and polychlorinated biphenyls (PCBs) were sent to a contractor laboratory. The contracts specified analytes, methods, required detection limits, and deliverables, which include standard batch QA/QC performance checks. Successful bidders were also required to provide BNL with a copy of their QA/QC manual as well as their QA Program Plan.

A contract for nonradiological sample analyses was established with H2M Laboratories, Inc. A second contract for nonradiological sample analyses was established with Chemtex Laboratory in order to provide special analytical services required to meet BNL discharge permit requirements for four analytes in wastewater samples collected from various recharge basins and one cooling tower. Contracts for radiological and nonradiological analyses were also established with GEL and STL.

### 9.5.2 QUALITY ASSURANCE PROGRAM FOR ANALYTICAL ACTIVITIES

For ASL analyses, procedures have been established to calibrate instruments, analyze samples, and assess QC. These procedures are consistent with EPA methodology and are described in Appendix D. QC checks were

performed and include analysis of blanks and instrument background; use of Amersham Radiopharmaceutical Company or National Institute for Standards and Technology (NIST) traceable standards; and analysis of reference standards, spiked samples, and duplicate samples. The ASL supervisor, QA officer, or group leader reviewed all ASL analytical and QA results before data were reported. Offsite contractor laboratories that perform radiological and chemical analyses for BNL are also required to maintain stringent QA programs.

A nonconformance report was generated when discrepancies were found in field sampling designs, documented procedures, chain-of-custody, calibration/standardization programs, acceptance criteria, statistical data analyses, QA software or data processing systems, or when failures in performance evaluation testing occurred. Corrective actions were then made following an investigation into the root cause.

## 9.6 ASL INTERNAL QUALITY ASSURANCE PROGRAM

This section further describes the QA requirements for analytical activities conducted as part of the 2000 BNL Environmental Monitoring Program, and the results of QA checks. ASL's nonradiological chemical group is certified by the NYSDOH ELAP to perform analyses utilizing EPA Methods 524 and 624 for volatile organic analytes, in potable and wastewaters, respectively. Thirty-seven VOCs are currently provided for analysis with Method 624 (for ground and wastewaters), an addition of 26 new analytes since 1998. EPA Method 524 (for potable water) includes 63 organic analytes and was a new addition to ASL's capabilities. Metals are analyzed utilizing both atomic absorption spectroscopy and inductively coupled plasma/mass spectroscopy by EPA Methods. ASL is now certified for analyses of 17 metals (the entire ELAP list) in potable water, as well as 21 metals in wastewater. Certification for three anions has been established for potable and wastewaters, using EPA Method 300.

In May 1999, ASL issued its own *QA Program Plan* (BNL 1999c) following EPA Region II guidelines (EPA 1998). Twenty-five internal operating procedures maintained by ASL were also revised in 2000. The QA procedures followed at ASL include daily instrument calibrations, efficiency and background checks, and routine tests for precision and accuracy. A detailed description of these activities can be found in the document titled *Year 2000 Quality Assurance Report of the Analytical Services Laboratory* (Scarpitta and Heotis 2001). A brief summary of ASL's QA Report follows.

### 9.6.1 RADIOLOGICAL INSTRUMENT CALIBRATIONS

ASL operates eight high-purity germanium gamma detectors. Each detector was calibrated daily for energy and instrument efficiency using a NIST traceable cesium-137 standard. Geometry efficiency calibrations are performed quarterly. Efficiency is the measure by which radiological decaying events are converted into observable counts (counts per minute). All eight gamma detectors performed well within the EPA acceptance limit of 1 keV during 2000.

ASL operates two gross alpha/beta (GAB) detectors and two liquid scintillation spectrometers for tritium. Instrument background and count-time are used to determine the MDL of a radiological analyte. In 2000, there was no unusual drift and/or variability in instrument background for alpha, beta, and tritium, based on the mean background count-rates (and one standard deviation) values of 0.062 ± 0.006, 1.612 ± 0.068, and 3.000 ± 0.168, respectively. Instrument efficiencies were determined daily, using a calibration standard, and averaged for the calendar year. All analyzers exhibited stable behavior and there were no unusual occurrences with existing instrumentation. The annual average efficiencies for alpha, beta, and tritium were 0.310 ± 0.001, 0.463 ± 0.001, and 0.241 ± 0.010, respectively.

### 9.6.2 PRECISION AND ACCURACY

Precision is the percent difference between two measured values, whereas accuracy is the percent difference between a measured value and its known (expected) value. The relative percent difference statistic is the measure of batch precision. It is defined as the absolute difference between two results, divided by the average of both results, multiplied by 100. Typically, a radioactive tracer solution (i.e., spike) is added to either a routine sample or tap water sample as a means of determining both precision and accuracy. In the case of nonradiological analyses, a known amount of a given analyte is added to a sample, and the percent recovery is the measure of accuracy.

The percent recovery is the ratio of the measured amount, divided by the known (spiked) amount, multiplied by 100.

For gross alpha/beta, the relative percent difference was determined for each batch of analyses performed. Tap water was spiked with known amounts of americium-241 (for alpha) and strontium/yttrium-90 (for beta) in order to determine batch precision. The acceptance criteria for batch precision are a relative percent difference less than 20% (for activity concentrations that are five times greater than the method MDL). During 2000, gross alpha/beta batch precision was consistently within the acceptable range 100% of the time. There were no rejected batches for gross alpha/beta analyses performed in 2000.

Tritium precision was determined for 429 batches processed in 2000. ASL utilizes three sampling protocols for differing sample volumes (i.e., 7 mL distilled, 7 mL undistilled, and 1 mL undistilled). In total, there were three rejected batches of tritium in 2000, representing a rejection rate of 0.7%. Each rejected batch was reprocessed and then passed QC with no loss of data. For seven batches of strontium-90 processed in 2000, there were no rejected batches.

Gross alpha/beta accuracy results for 268 batches processed showed no failures based on the EPA's acceptance criteria of ± 25% for recovery.

#### 9.6.3 NONRADIOLOGICAL: ORGANIC AND INORGANIC ANALYSES

Method precision was determined for 11 organic compounds, 3 anions and 20 metals processed by ASL in 2000. All analytes had relative percent differences within ASL's internal acceptance limit of ± 20%. The three standard deviation uncertainties were also within the EPA acceptance criteria of ±20%.

ASL has an internal QC program for the ion chromatography and atomic absorption methods used for inorganic analyses. One hundred and four batch checks were performed in 2000 for metals and anions. For the 21 certified metals analyzed by ASL, only beryllium and aluminum exceeded the three standard deviation EPA acceptance criteria for recovery. For aluminum, this was attributable to two reference check recovery values of 160% and 300% in March and December, respectively, that resulted in an overall three sigma standard deviation value that was higher than acceptable. For beryllium, three recovery values (130%, 122% and 110%) in the month of June resulted in an overall three sigma standard deviation value that was higher than acceptable. For this reason, analytical data for both aluminum and beryllium from the months in question were "qualified" but still usable.

The ASL has an internal QC program for the gas chromatography/mass spectroscopy method used for 14 primary VOCs. Recoveries and 99% confidence intervals were determined for 39 independent VOC measurements. Average recoveries for all of the 14 analytes were within their target ranges of ± 25%.

The 99% confidence intervals for surrogate recoveries were also determined for three additional analytes in 2000. The recovery range for 4-bromofluorobenzene was 75 - 125%. The recovery ranges for toluene and dibromofluoromethane were 80 - 120% and 80 - 115%, respectively. All surrogate recoveries were within EPA acceptance limits.

### 9.7 PERFORMANCE EVALUATION TESTING

As in prior years, ASL and three contractor laboratories participated in several national and state performance evaluation testing programs. Results of those performance evaluation tests provide information on the quality of a laboratory's analytical capabilities. As noted above, performance evaluation testing data are not presented in this report for the fourth contractor, Chemtex Laboratory, because no ERA or NYSDOH performance evaluation testing program includes the specific analytes analyzed by this laboratory. Chemtex only performed four chemical analyses for BNL on the following analytes: dibromo-nitrilo-propionamide, tolytriazole, polypropylene-glycol-monobutyl-ether, and 1,1-hydroxyethylidene-diphosphonic acid.

Effective December 21, 1998, EPA's performance evaluation programs for both radiological and nonradiological analytes were terminated. Environmental Resources Associates (ERA), a private independent performance evaluation program, was chosen by ASL to replace EPA's radiological and nonradiological performance evaluation program. During 2000, ASL, GEL, STL, and H2M participated in either the NYSDOH Environmental Laboratory Approval Program (ELAP) (for radiological and nonradiological proficiency evaluation

testing) or the DOE Environment Measurements Laboratory (EML) Quality Assessment Program (radiological only). These laboratories participated in at least one performance evaluation program, although in several cases these labs participated in several programs. The results from these blind, independent tests are provided below.

### 9.7.1 SUMMARY OF PERFORMANCE EVALUATION TEST RESULTS

During 2000, BNL's overall satisfactory *radiological* scores in the NYSDOH ELAP and DOE Program were equivalent to its offsite contractor laboratory (GEL), with an 89% rate of satisfactory results, whereas in the ERA radiological program, both BNL and GEL achieved 94% and 95% rates of satisfactory scores, respectively. For *nonradiological* results, the overall rate of satisfactory results ranged from 92 to 99% for BNL, H2M, GEL and STL in both ERA and NYSDOH testing programs.

Figures 9-2 and 9-3 summarize the 2000 scores of ASL and the three contractor laboratories that participated in the mandatory U.S. DOE EML QA Program (for radiological analytes only) and the NYSDOH ELAP, as well as the voluntary ERA program. The bar graphs of Figures 9-2 and 9-3 summarize all tabulated radiological and nonradiological results (as percentage scores) that were acceptable, within warning limits, or unacceptable, for each analytical laboratory, and by performance evaluation testing program. A "warning" is considered satisfactory, being within two and three standard deviations of the target value, and an "unacceptable" result is greater than three standard deviations of the target value. An "overall satisfactory" score is the sum of results rated as acceptable and those rated as "warning," divided by the total number of results reported. Tabulated results are presented in Appendix F and are described in detail in Sections 9.7.2 and 9.7.3, below.

### 9.7.2 RADIOLOGICAL ASSESSMENTS

Both ASL and GEL participated in the DOE EML Quality Assessment Program and the NYSDOH ELAP. Overall, ASL's performance in the DOE EML performance evaluation program was satisfactory in 90.7% of the analyses performed on four matrices (air, vegetation, water, and soil), as shown in Table F-2. Twenty-seven of 43 analyses (62.8%) were within established DOE EML limits, showing acceptable agreement with the known value. Twelve results (27.9%) were within warning limits, demonstrating satisfactory agreement. Four analyses (9.3%) fell outside the acceptance limits. The four results that were not acceptable (H3, Sr-90, alpha and beta) occurred in the March round of testing, but were acceptable in the September round of EML testing.

GEL's performance for radiological analyses in DOE's EML performance evaluation program is also presented in Table F-2. GEL's performance in the DOE EML intercomparison study was acceptable or within warning limits in 97% of the analyses performed on the four matrices (air, vegetation, water, and soil). Seventy-one of 96 analyses (74%) were within EML's acceptance limit; 22 of 96 analyses (23%) were within upper and lower warning limits, demonstrating satisfactory agreement; 3 analyses (3%) fell outside the acceptance limits.

ASL's radiological results for the NYSDOH ELAP performance evaluation program were in 75% agreement for the four analyses, as shown in Table F-3. The one result that was unacceptable for beta in the April 2000 round was acceptable in the November 2000 round. For the same performance evaluation program, GEL had an overall satisfactory score of 90% on the ten analytes shown in Table F-3.

Both ASL and GEL participated in several voluntary ERA radiological performance evaluation studies shown in Table F-4. The overall ASL score on the thirty results reported in 2000 was 93.3% with two unacceptable tritium results. A review of internal QC checks showed a 15% to 20% negative bias in tritium measurements during the year that resulted in unacceptable tritium results in the ERA performance evaluation testing program. ASL had performed successfully in the September round of tritium testing in the DOE EML intercomparison, as shown in Table F-2, but not in the March round. The negative bias issue has since been resolved after the root cause of the problem was identified.

The actual negative bias in tritium was within the EPA acceptance limit of ± 25%, so

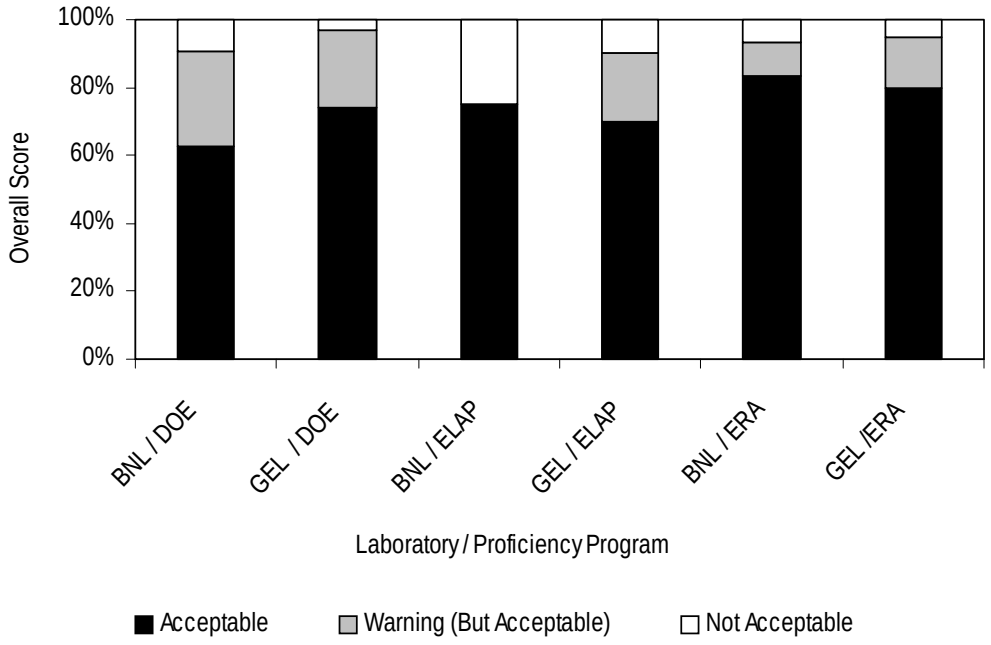


**Figure 9-2. Summary of 2000 Performance Evaluation Scores in DOE, NYSDOH ELAP, and ERA Radiological Programs.**

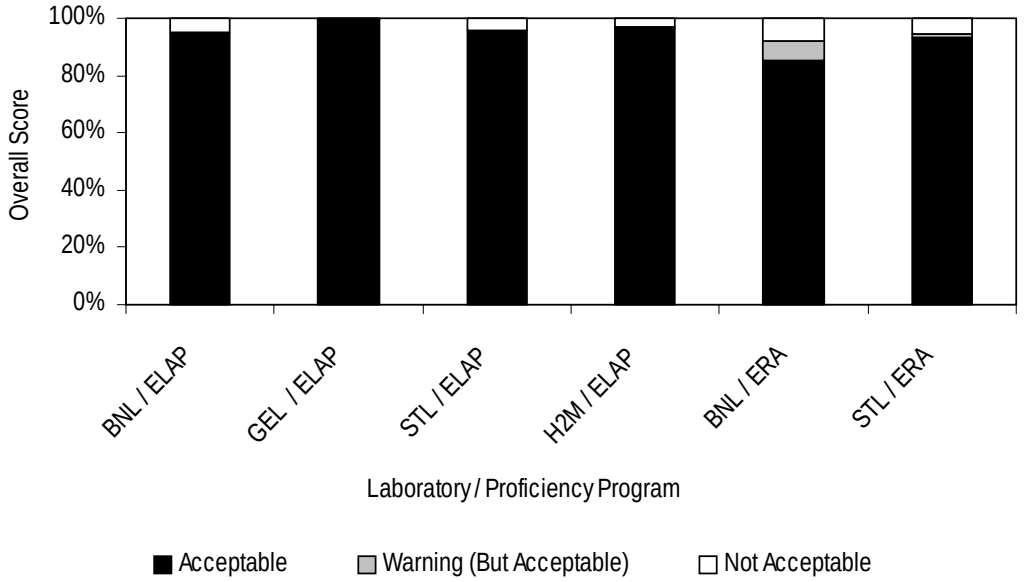


**Figure 9-3. Summary of 2000 Performance Evaluation Scores in DOE, NYSDOH ELAP, and ERA Nonradiological Programs.**

that no ASL data were qualified or rejected. GEL's overall score in the ERA radiological performance evaluation studies was 94.7% for 19 analytes reported as shown in Table F-4. One unacceptable result was reported for radium-226.

### 9.7.3 NONRADIOLOGICAL ASSESSMENTS

ASL, GEL, STL, and H2M participated in the NYSDOH ELAP during 2000. The NYSDOH certifies laboratories for nonpotable water, potable water and solid wastes. These results are summarized in Tables F-5 through

F-7 as "satisfactory," "warning," "unsatisfactory" or "not tested," for each of the four laboratories. (Note that STL has two labs: one in Missouri and one in Connecticut.) Although not required for New York State certification, ASL and STL also participated in the ERA water supply and water pollution studies which are presented in Table F-8.

Results for the NYSDOH ELAP for nonpotable water are shown in Tables F-5. There were a total of 85 results reported by ASL with five unacceptable results. In the ELAP nonpotable water category, ASL's overall satisfactory score was 94.1%. GEL reported results for 365 analytes with one unacceptable result, corresponding to an overall satisfactory score of 98.1%. There were 582 results reported by H2M, with 16 unacceptable results corresponding to an overall satisfactory score of 97.3% . STL's performance in the NYSDOH ELAP nonpotable water studies is shown separately for both the Missouri and Connecticut laboratories. The Missouri laboratory reported 182 results with an overall satisfactory score of 96.2%, whereas the Connecticut laboratory reported 585 results for an overall satisfactory score of 96.8%.

Results for the NYSDOH ELAP Solid and Hazardous Waste Chemistry Proficiency Program are shown in Table F-6 for ASL only. For the twenty-three results reported, ASL scored 100% in this category

Table F-7 summarizes results of the potable water category of the NYSDOH ELAP. ASL reported 142 results with 134 acceptable and 8 unacceptable results, corresponding to an overall satisfactory score of 94.4%. GEL reported 161 results with 158 acceptable and 3 unacceptable results, corresponding to an overall satisfactory score of 98.1%.

H2M reported 195 results with 189 acceptable and 6 unacceptable results, corresponding to an overall satisfactory score of 96.9%. STL (Missouri) reported 159 results with 149 acceptable and 10 unacceptable results, corresponding to an overall satisfactory score of 91.2 %.

ASL and STL participated in the voluntary ERA water pollution and water supply performance evaluation studies, as shown in Table F-8. For both water supply and water pollution studies, ASL reported 217 results with 185 acceptable, 15 within warning limits, and 17 unacceptable results. The overall satisfactory score for ASL in ERA's water supply and water pollution studies was 92.1%. STL (Connecticut) reported 381 results with 356 acceptable, 4 warning and 21 unacceptable. The overall satisfactory score for STL in the ERA water supply and water pollution studies was 94.5%.

### 9.8 LABORATORY AUDITS

In addition to performance evaluation testing, BNL conducts a program of internal and external audits to verify the effectiveness of the environmental sampling, analysis, and database activities. Contractor laboratories were subject to audits by BNL personnel at the time of contract renewal. The contractor laboratories were audited periodically by ASL and/or Environmental Restoration Program staff to verify competence in analytical methodology and implementation of a comprehensive QA program.

During 2000, ASL began contract renewal and bid processes for both GEL and H2M. The audits of these two laboratories occurred in the spring of 2000 and there were no significant findings. An audit of Chemtex is planned for late 2001, when the existing contract expires.

The BNL Quality Management Office, DOE Brookhaven Group, DOE Chicago Operations, regulatory agencies, and other independent parties also periodically audit BNL environmental programs, as discussed in Chapters 2 and 3.

### 9.9 CONCLUSIONS

Detailed data on quality control results for all analyses conducted at BNL's ASL are presented in ASL's *Year 2000 QA Report* (Scarpitta and Heotis, 2001). The report presents tables and figures depicting instrument calibration, efficiency and background checks, and precision and accuracy testing. Overall, QC checks were consistently within the EPA guidelines of ±20%.

Detailed data on external performance evaluation testing are also presented in the Year 2000 QA Report for the ASL and three offsite contractor laboratories. Overall, the two laboratories (ASL and GEL) reporting radiological analytical data in the *Site Environmental Report 2000* had combined satisfactory results of 89% and 96%, respectively, in both state and federal performance evaluation programs. For nonradiological performance

evaluation testing, ASL and the three BNL contractor laboratories (H2M, GEL, and STL) all scored over 92% in the NYSDOH ELAP evaluations.

Based on implementation and evaluation of the QA/QC program, it can be concluded that the analytical data reported in the *Site Environmental Report 2000* are reliable and of high 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.

| | |
|---|---|
| AGS | Alternating Gradient Synchrotron |
| ALARA | as low as reasonably achievable |
| AMSL | above mean sea level |
| AOC | area of concern |
| AS/SVE | air sparging/soil vapor extraction |
| ASL | Analytical Services Laboratory (BNL) |
| AUI | Associated Universities, Incorporated |
| BGRR | Brookhaven Graphite Research Reactor |
| BLIP | Brookhaven Linac Isotope Producer |
| BMRR | Brookhaven Medical Research Reactor |
| BNL | Brookhaven National Laboratory |
| BOD | biochemical oxygen demand |
| Bq | becquerel |
| Bq/g | becquerel per gram |
| Bq/L | becquerel per liter |
| BSA | Brookhaven Science Associates |
| Btu | British thermal units |
| CAA | Clean Air Act |
| CAP | Clean Air Act Assessment Package |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act |
| CFR | U.S. Code of Federal Regulations |
| Ci | curie |
| CO | certificate to operate |
| Cs | cesium |
| CSF | Central Steam Facility |
| CT | carbon tetrachloride |
| CWA | Clean Water Act |
| CY | calendar year |
| DCA | 1,1-dichloroethane |
| DCE | 1,1-dichloroethylene |
| DCG | derived concentration guide |
| DDD | dichlorodiphenyldichloroethane |
| DDT | dichlorodiphenyltrichloroethane |
| DMR | Discharge Monitoring Report |
| DOE | U.S. Department of Energy |
| DOE BAO | U.S. Department of Energy, Brookhaven Area Office |
| DOE CH | U.S. Department of Energy, Chicago Operations Office |
| DQO | data quality objective |
| DWS | drinking water standards |
| EA | environmental assessment |
| EDB | ethylene dibromide |
| EDE | effective dose equivalent |
| EDTA | ethylenediaminetetraacetic acid |
| ELAP | Environmental Laboratory Approval Program |
| EMS | Environmental Management System |
| EPA | U.S. Environmental Protection Agency |
| EPCRA | Emergency Planning and Community Right-to-Know Act |
| ER | environmental restoration |
| ERA | Environmental Resource Associates |
| ERD | Environmental Restoration Division |
| ES | environmental surveillance |
| ES&H | environment, safety, and health |
| ESD | Environmental Services Division |
| ESH&Q | Environment, Safety, Health, and Quality Directorate |
| FFCA | Federal Facilities Compliance Act |
| FIFRA | Federal Insecticide Fungicide and Rodenticide Act |
| FY | fiscal year |
| GAB | gross alpha beta |
| GC/ECD | gas chromatography/electron capture detector |
| GC/MS | gas chromatography/mass spectrometry |
| GEL | General Engineering Laboratory |
| GWh | gigawatt hour |
| HEPA | high efficiency particulate air |
| HFBR | High Flux Beam Reactor |
| HTO | tritiated water (liquid or vapor) |
| HWMF | Hazardous Waste Management Facility (former) |
| IAEA | International Atomic Energy Agency |
| IAG | Interagency Agreement |
| IC | ion chromatography |
| ICP/MS | inductively coupled plasma/mass spectrometry |
| ISO | International Organization for Standardization |
| K | potassium |
| kBg | kilobecquerels |
| kwH | kilowatt hours |
| LED | light emitting diode |
| LIE | Long Island Expressway |
| LINAC | Linear Accelerator |
| MBtu | thousand British thermal units |
| MMBtu | million British thermal units |
| MDL | minimum detection limit |
| MEI | maximally exposed individual |
| MGD | million gallons per day |
| MOA | Memorandum of Agreement |

| | |
|---|---|
| MPF | Major Petroleum Facility |
| MPN | most probable number |
| MRC | Medical Research Center |
| mSv | millisievert |
| MTBE | methyl tertiary butyl ether |
| MW | megawatt |
| µg/L | micrograms per liter |
| mg/L | milligrams per liter |
| mmhos/cm | micro ohm/centimeters |
| NA | not analyzed |
| NCRP | National Council on Radiation Protection and Measurements |
| ND | not detected or no dose |
| NEPA | National Environmental Policy Act |
| NESHAPs | National Emission Standards for Hazardous Air Pollutants |
| NIST | National Institute for Standards and Technology |
| $NO_2$ | nitrogen dioxide |
| $NO_X$ | nitrogen oxides |
| NOEC | no observable effect concentration |
| NPDES | National Pollutant Discharge Elimination System |
| NR | not required |
| NS | not sampled |
| NSLS | National Synchrotron Light Source |
| NT | not tested |
| NYCRR | New York Codes, Rules, and Regulations |
| NYS | New York State |
| NYS AWQS | New York State ambient water quality standard |
| NYS DWS | New York State drinking water standard |
| NYSDEC | New York State Department of Environmental Conservation |
| NYSDOH | New York State Department of Health |
| NYSHPO | New York State Historic Preservation Office |
| $O_3$ | ozone |
| ORPS | Occurrence Reporting and Processing System |
| OU | operable unit |
| P2 | pollution prevention |
| Pb | lead |
| PCB | polychlorinated biphenyl |
| PCE | tetrachloroethylene (or perchloroethylene) |
| pCi/g | picocuries per gram |
| PE | performance evaluation |
| PET | positron emission tomography |
| ppb | parts per billion |
| ppm | parts per million |
| QA | quality assurance |
| QAPP | quality assurance program plan |
| QC | quality control |
| RA | removal action |
| RACT | Reasonable Available Control Technology |
| RCRA | Resource Conservation and Recovery Act |
| RHIC | Relativistic Heavy Ion Collider |
| ROD | record of decision |
| RPD | relative percent difference |
| SARA | Superfund Amendments and Reauthorization Act |
| SBMS | Standards Based Management System |
| SCDHS | Suffolk County Department of Health Services |
| SDWA | Safe Drinking Water Act |
| SER | Site Environmental Report |
| SNS | standard not specified |
| $SO_2$ | sulfur dioxide |
| SOP | standard operating procedure |
| SPCC | spill prevention control and countermeasures |
| SPDES | State Pollutant Discharge Elimination System |
| STL | Severn Trent Laboratories |
| STP | Sewage Treatment Plant |
| SU | standard unit |
| Sv | sievert |
| SVOC | semivolatile organic compound |
| $t_{1/2}$ | half-life |
| TBq | trillion Becquerels |
| TCA | 1,1,1-trichloroethane |
| TCE | trichloroethylene |
| TCLP | toxicity characteristic leaching procedure |
| TLD | thermoluminescent dosimeter |
| TSCA | Toxic Substances Control Act |
| TVOC | total volatile organic compounds |
| UIC | underground injection control |
| UST | underground storage tank |
| VOC | volatile organic compound |
| WCF | Waste Concentration Facility |
| 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. For definitions and descriptions of the various environmental regulations see Chapter 3.

## A

**accuracy** - The degree of agreement of a measurement with an accepted reference or true value. It is 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 products** - A material that has become radioactive through the process of activation.

**activity** - Synonym for radioactivity.

**Administrative Record** - A collection of documents established in compliance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program. Consists of information upon which the CERCLA lead agency bases 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.

**aerosol** - A gaseous suspension of very small particles of liquid or solid.

**air sparging** - A method of extracting volatile organic compounds from the groundwater *in situ* (i.e., in place) using compressed air. The vapors are typically collected using a soil vapor extraction system.

**air stripping** - A process whereby volatile organic chemicals are removed from contaminated water by forcing a stream of air through the water in a vessel. The contaminants are evaporated into the air stream. The air may be further treated before it is released into the atmosphere.

**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 elements such as radon emit alpha radiation.

**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.

**anion** - A negatively charged ion, often written as a negative sign after an element symbol, such as Cl-.

**anthropogenic radionuclides** - Radionuclides produced as a result of human activity (i.e., human-made).

**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.

**area of concern (AOC)** - Under the Comprehensive Environmental Response, Compensation and Liability Act (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 into the environment 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.

**atomic absorption (AA)** - A method used to determine the elemental spectroscopy composition of a

sample. In this method, the sample is vaporized and the amount of light it absorbs is measured.

## 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, cosmic radiation, or human-made radiation sources, including fallout.

**becquerel (Bq)** - A quantitative measure of radioactivity. This is an alternate measure of activity used internationally and with increasing frequency in the United States. One Bq of activity is equal to one nuclear decay per second. All references to quantities of radioactive material in this report are made in curies, followed in parentheses by the equivalent in Bq.

**beta radiation** - Beta radiation is composed of charged particles emitted from a nucleus during radioactive decay, with a mass equal to 1/1837 that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Beta radiation is slightly more penetrating than alpha, but may be stopped by materials such as aluminum or Lucite panels. Naturally occurring radioactive elements such as potassium-40 emit beta radiation.

**biochemical oxygen demand (BOD)** - 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.

**blank** – A sample (usually reagent grade water) in the same type of container 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).

## C

**cap** - A layer of material, such as clay or a synthetic material (like Gunite™), used to prevent rainwater from penetrating and spreading contaminated materials. 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, $CCl_4$.

**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.

**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.

**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 potable water.

**closure** - Under the Resource Conservation and Recovery Act (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.

**Code of Federal Regulations (CFR)** - A codification of all regulations developed and finalized by federal agencies in the Federal Register.

**collective effective dose equivalent** - A measure of health risk to a population exposed to radiation. It is the sum of the effective dose equivalents 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 Effective Dose Equivalent received over a 50-year period following the internal deposition of a radionuclide. It is expressed in rem or sieverts.

**composite sample** - A sample of an environmental media that contains a certain number of sample portions collected over a period of time. The samples may be collected from the same location or different locations. They may or may not be collected at equal time intervals over a predefined period of time (e.g., 24 hours).

**confidence interval** - A numerical range within which the true value of a measurement or calculated value lies. In this report, radiological values are shown with a 95% confidence interval, i.e., there is a 95% probability that the true value of a measurement or calculated value lies within the specified range.

**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 that is used to cool machinery and equipment. Contact cooling water is any wastewater that contacts machinery or equipment to remove heat from the metal. Non-contact cooling water is water used for cooling purposes but has no direct contact with any process material or final product. Process wastewater cooling water is water used for cooling purposes that may have become contaminated through contact with process raw materials or final products.

**curie (Ci)** - A quantitative measure of radioactivity. One Ci of activity is equal to $3.7 \times 10^{10}$ decays per second.

## D

**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.

**Department of Energy (DOE)** - The federal agency that sponsors energy research and regulates nuclear materials used for weapons production. DOE has responsibility for the national laboratories and the science and research conducted at these laboratories, including BNL.

**derived concentration guide (DCG)** - 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/immersion, water ingestion), would result in an effective dose equivalent of 100 mrem (1 mSv). The values have been established by DOE in Order 5400.5, *Radiation Protection of the Public and the Environment*. 1990, change 2, 1/7/93.

**disposal** - Final placement or destruction of waste.

**dosimeter** - A portable detection device for measuring the total accumulated exposure to ionizing radiation.

**downgradient** - In the direction of groundwater flow from a designated area; analogous to "downstream."

## E

**effective dose equivalent (EDE)** - A value used to express the health risk from radiation exposure to a tissue or tissues 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. It is equal to the sum of the doses to different organs of the body multiplied by their respective weighting factors. It includes the sum of the effective dose equivalent 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 units of rem or sieverts.

**effluent** - Any liquid discharged to the environment, including stormwater runoff at a site or facility.

**emission** - Any gaseous or particulate matter discharged to the atmosphere.

**environment** - Surroundings in which an organization operates (including air, water, land, natural resources, flora, fauna, and humans) and their interrelation.

**environmental aspect** - Elements of an organization's activities, products, or services that can interact with the environment.

**environmental assessment (EA)** - A report that identifies potentially significant environmental impacts from any federally approved or funded project that may change the physical environment. If an EA identifies a "significant" impact (as defined by the National Environmental Policy Act [NEPA]), an Environmental Impact Statement is required.

**environmental impact** - Any change to the environment, 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** - Sampling for contaminants in air, water, sediments, soils, food stuffs, plants, and animals, either by directly measuring or by collecting and analyzing samples.

**Environmental Protection Agency (EPA)** - The federal agency responsible for developing and enforcing environmental laws. Although state regulatory agencies may be authorized to administer environmental regulatory programs, EPA generally retains oversight authority.

**ethylene dibromide (EDB)** - A colorless, nonflammable, heavy liquid with a sweet odor; slightly soluble in water, soluble in ethanol, ether, and most

organic solvents. It was used as an additive in leaded gasoline, as a soil and grain fumigant, and in waterproofing preparations. 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. The U.S. Department of Health and Human Services has determined that ethylene dibromide may reasonably be anticipated to be a carcinogen.

**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.

**feasibility study (FS)** - 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.

## 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" to identify a specific nuclide.

**grab sample** - A single sample collected at one time and place.

**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 on a metal mold.

## 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.

**hazardous waste** - Toxic, corrosive, reactive, or ignitable materials that can negatively affect 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 the Resource Conservation and Recovery Act (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.

**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 (e.g., 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 other sources (e.g., a sewage treatment plant).

**ionizing radiation** - Any radiation capable of displacing electrons from atoms or molecules, thereby producing ions. Some examples are alpha, beta, gamma, x-rays, neutrons, and light. High doses of ionizing radiation may produce severe skin or tissue damage.

**isotope** - Two or more forms of a chemical element having the same number of protons in the nucleus (or the same atomic number), but having different numbers of neutrons in the nucleus (or 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** – Tap water.

**liquid scintillation counter** - An analytical instrument used to quantify tritium, carbon-14, and other beta-emitting radionuclides.

## M

**maximally exposed individual (MEI)** - 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.

**mean sea level (MSL)** - The average height of the sea for all stages of the tide. Used as a benchmark for establishing groundwater and other elevations.

**minimum detection limit (MDL)** - 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 measurable, they represent values that have a reduced statistical confidence associated with them (less than 95% confidence).

**mixed waste** - Waste that contains both a hazardous waste component regulated under Subtitle C of the Resource Conservation and Recovery Act (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.

## N

**nuclide** - A species of atom characterized by the number of protons and neutrons in the nucleus.

## O

**onsite** - 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 emissions (e.g., smoke) other than water reduce the transmission of light and obscure the view of an object in the background.

**operable unit (OU)** - 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 operable unit can receive specific investigation and a particular remedy may be proposed. A record of decision (ROD) is prepared for each operable unit (*see* Record of Decision).

**outfall** - The place where wastewater is discharged.

**oxides of nitrogen ($NO_x$)** - All oxides of nitrogen, except nitrous oxide, which is expressed as nitrogen dioxide ($NO_2$).

**ozone ($O_3$)** - A very reactive form of oxygen formed naturally in the upper atmosphere and providing 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

**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 the Resource Conservation and Recovery Act (RCRA), Clean Air Act (CAA), Clean Water Act (CWA), and Toxic Substances Control Act (TSCA). They grant permission to operate, to discharge, to construct, etc. 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 media, such as air, soil, water, or vegetation.

**pollution prevention (P2)** - 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.

**polychlorinated biphenyls (PCBs)** - 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.

**potable water** - Water of sufficient quality for use as drinking water without endangering the health of people, plants, or animals.

**precision** - The dispersion 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

**qualifier** – A letter or series of letter codes indicating that the associated value is estimated. A qualified value is an estimated value.

**quality assurance (QA)** - 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.

**quality control (QC)** - 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.

## R

**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.

**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.

**Record of Decision (ROD)** - A document that records a regulator 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.

**relative percent difference** – A measure of precision, expressed by the formula: RPD = [(A-B)/(A+B)] x 200, where A equals the concentration of the first replicate: and B equals the concentration of the second replicate.

**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. This is a risk-based value used to estimate the potential health effects to an exposed individual or population.

**remedial (or remediation) alternatives** - Options considered under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) for cleaning up contamination at a site, such as an operable unit (OU) or area of concern (AOC). Remedial actions are long-term activities that stop or substantially reduce releases, or prevent possible releases, of hazardous substances that are

serious but not immediately life-threatening. See also feasibility study (FS) and record of decision (ROD).

**remedial investigation (RI)** - An investigation that includes extensive sampling and laboratory analyses to characterize the nature and extent of contamination, define the pathways of migration, and measure the degree of contamination in surface water, groundwater, soils, air, plants, and animals. Information gathered during the RI attempts to fully describe the contamination problem at the site so that the appropriate remedial action can be developed.

**removal actions (RA) or 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 Comprehensive Environmental Response, Compensation, and Recovery Act (CERCLA), and that are not inconsistent with the final remedial action. Under CERCLA or Superfund, the U.S. Environmental Protection Agency may respond to releases or threats of releases of hazardous substances by starting a removal action. The purpose of the removal action is to stabilize or clean up an incident or site that poses an immediate threat to public health or welfare. Removal actions differ from remedial actions. However, removal actions must contribute to the efficiency of future remedial actions.

**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).

**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.

**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 (Sv)** - 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.

**skyshine** - Radiation emitted over an open-topped shielded enclosure and reflected by air so as to radiate people on the outside.

**sludge** - Semisolid residue from industrial or water treatment processes.

**soil vapor extraction** - An *in situ* (in place) method of extracting volatile organic chemicals from soil. The chemicals are extracted by applying a vacuum to the soil and collecting the air, which can be further treated to remove the chemicals or discharged to the atmosphere.

**sole source aquifer** - An area defined by the U.S. Environmental Protection Agency 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.

**spallation** - The process by which a high energy particle striking a nucleus causes fragments to be ejected from the nucleus. The resulting atom is usually radioactive.

**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; the U.S. Department of Energy; and BNL staff.

**State Pollution Discharge Elimination System (SPDES)** - A program under which permits are issued by the state to regulate wastewater discharges. The permit specifies the maximum discharge limits for the parameters present in the particular discharge.

**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.

## T

**thermoluminescent dosimeter (TLD)** - A device used to measure radiation dose to occupational workers or radiation levels in the environment.

**total volatile organic compounds (TVOC)** - A sum of all individual VOC concentrations detected in a given sample.

**trichloroethylene (TCE) (also, 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 to people when inhaled or ingested, or through skin contact, and can damage vital organs, especially the liver (*see also* volatile organic compounds).

**tritium** - The heaviest and only radioactive nuclide of hydrogen, with a half-life of 12.3 years and a very low energy radioactive decay (beta emitter).

## U

**underground injection control (UIC)** – Any hole whose vertical dimensions are larger than its largest horizontal dimensions and used for disposal of waste water.

**underground storage tank (UST)** - A stationary device, constructed primarily of nonearthen material, designed to contain petroleum products or hazardous materials. In a UST, 10% 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

**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 spotted salamander), as it is too shallow to support fish, a major predator of amphibian larvae.

**volatile organic compounds (VOCs)** - Secondary petrochemicals, including light alcohols, acetone, trichlorethylene, perchloroethylene, dichloroethylene, benzene, vinyl chloride, toluene, and methylene chloride. These potentially toxic chemicals are used as solvents, degreasers, paints, thinners, and fuels. Because of their volatile nature, they readily evaporate into the air, increasing the potential for human exposure. Due to their widespread industrial use, they are commonly found in soil and groundwater.

## W

**waste minimization** - An action that avoids or reduces the generation of waste by source reduction, reduces the toxicity of hazardous waste, improves energy usage, or recycling. This action is consistent with the general goal of minimizing present and future threats to human health, safety, and the environment. Associated with pollution prevention, but more likely to occur after the waste has already been generated.

**water table** - The water-level surface below the ground at which the unsaturated zone ends and the saturated zone begins. It is the level to which a well that is screened in the unconfined aquifer would 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.

**wind rose** - A diagram that shows the frequency of wind from different directions at a specific location.

# *Concepts of Radioactivity*

This section introduces some of the basic concepts of radioactivity. It is designed to provide the general reader with an overall understanding of the radiological sections of this report. A discussion of the analyses used to qualitatively quantify radioactive material, the common sources of radioactivity in the environment, and how they contribute to an individual's radiation dose are provided. Some general statistical concepts are also presented, along with a discussion of radionuclides of environmental interest at BNL.

## RADIOACTIVITY

The atom is the basic constituent of all matter and is one of the smallest units into which matter can be divided. Each atom is composed of a tiny central core of particles, or nucleus, surrounded by a cloud of negatively charged particles called electrons. Most atoms in the physical world are stable, meaning that they are not radioactive. However, some atoms possess excess energy, which causes them to be physically unstable. In order to become stable, an atom rids itself of this extra energy by casting it off in the form of charged particles or electromagnetic waves, known as radiation.

## COMMON TYPES OF RADIATION

The three most important types of radiation are described below:

### ALPHA

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. Naturally occurring radioactive elements such as uranium and radon daughters emit alpha radiation.

### BETA

Beta radiation is composed of particles that are identical to electrons. As a result, beta particles have a negative charge. Beta radiation is slightly more penetrating than alpha but may be stopped by materials such as aluminum foil and Lucite™ panels. They have a range in air of several feet. Naturally occurring radioactive elements such as potassium- 40 (K-40) emit beta radiation.

### GAMMA

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. X-rays are similar to gamma radiation.

## NOMENCLATURE

Throughout this report, radioactive elements (also called radionuclides) are referred to by a name followed by a number, e.g., cesium-137. The number following the name of the element is called the mass of the element and is equal to the total number of particles contained in the nucleus of the atom. Another way to specify the identity of cesium-137 is by writing it as Cs-137, where 'Cs' is the chemical symbol for cesium as it appears in the standard Periodic Table of the Elements. This type of abbreviation is used in the text and many of the data tables in this report.

**DOSE UNITS**

The amount of energy that radiation deposits in body tissues or organs, when corrected for human risk factors, is referred to as dose equivalent or, more generally, as dose. Radiation doses are measured in units of rem. Since the rem is a fairly large unit, it is convenient to express most doses in terms of millirem (1,000 mrem = 1 rem). To give a sense of the size and importance of a 1 mrem dose, Figure B-1 indicates the number of mrem received by an individual in one year from natural and background sources. These values represent typical values for residents of the United States. Note that the alternate unit of dose measurement commonly used internationally and increasingly in the United States is the sievert, abbreviated Sv. One Sv is equivalent to 100 rem. Likewise, 1 millisievert (mSv) is equivalent to 100 mrem.

**SOURCES OF RADIATION**

Radioactivity and radiation are part of the earth's natural environment. Human beings are exposed to radiation from a variety of common sources, the most significant of which are listed below.

**COSMIC**

Cosmic radiation primarily consists of charged particles that originate in space, beyond the Earth's atmosphere. This includes 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. The average dose from cosmic radiation to a person living in the United States is about 26 mrem per year.

**TERRESTRIAL**

Terrestrial radiation is released by radioactive elements present in the soil since the formation of the Earth about five billion years ago. Common radioactive elements contributing 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 about 28 mrem per year.

**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. Human ingestion of radionuclides can occur when contaminated plant matter or animals that consume contaminated plant matter are eaten. Most exposure to inhaled radioactive material results from breathing the decay products of naturally occurring radon gas. The average dose from eating foods to a person living in the United States is about 40 mrem per year; the average dose from radon product inhalation is about 200 mrem per year.

**MEDICAL**

Millions of people every year undergo medical procedures that utilize radiation. Such procedures include chest and dental x-rays, mammography, thallium heart stress tests, and tumor irradiation therapies. The average dose from nuclear medicine and x-ray examination procedures in the United States is about 14 and 39 mrem per year, respectively.

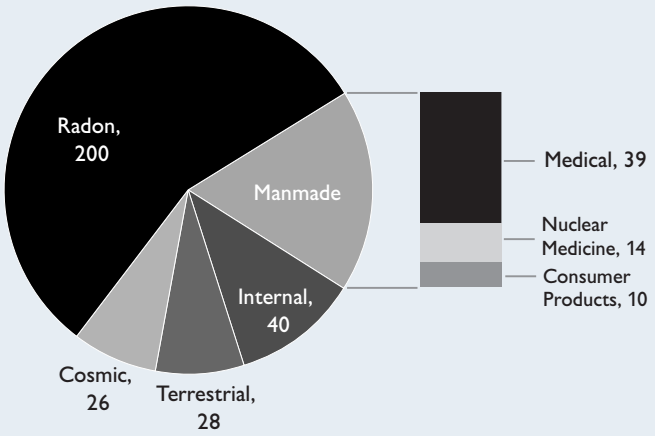


**Figure B-1. Typical Annual Radiation Doses from Natural and Man-made Sources (mrem).** *Source: NCRP Report No. 93 (NCRP 1987).*

**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 of the 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).

## TYPES OF RADIOLOGICAL ANALYSIS

The quality of environmental air, water, and soil with respect to radioactive material can be assessed using several types of analysis. The most common analyses are described below.

### GROSS ALPHA

Alpha particles are emitted 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 magnitude of alpha-emitting radionuclides that may be present in a sample.

### GROSS BETA

This is the same concept as described above, except that it applies to the measurement of beta particle activity.

### TRITIUM

Due to the nature of the radiation, a low energy beta particle, emitted from the tritium atom, it is detected and quantified by liquid scintillation counting method. (More information on tritium is presented below.)

### STRONTIUM-90

Due to the nature of the radiation emitted by strontium-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 strontium-90 is presented below.)

### GAMMA

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" to identify a specific nuclide.

The unit used to express the quantity of radioactive material in a sample is the curie (Ci). This is a measure of the rate at which radioactive atoms are transformed to stable atoms. Since the curie is a relatively large unit for measuring environmental samples, the picocurie (pCi) is often used. This unit is equal to one trillionth of a Ci, or 0.037 decays per second. The alternate unit for quantifying radioactivity is the becquerel, abbreviated Bq. One becquerel is equal to 1 decay per second. Additional units of measure and their conversion factors can be found on the inside of the back cover of this report.

## 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 will yield a slightly different result each time; a single measurement is, therefore, not definitive. To account for this phenomenon, the concept of uncertainty is applied to radiological data. In this report analysis results are displayed with x ± y format, where x is the result and ± y is the 95 percent confidence interval of the result. That is, there is a 95 percent probability that the true value of x lies between x + y and x - y. Conversely, there is a 5 percent probability that the true value of x lies outside of this range.

### NEGATIVE VALUES

There is always a small amount of natural radiation in the environment. The instruments used in the laboratory to measure radioactivity in BNL site environmental media are sensitive enough to measure the natural, or background, radiation along with any contaminant radiation in a sample. To obtain a true measure of the contaminant level in a sample, the natural (or background) radiation level must be subtracted from the total amount of radioactivity measured by an instrument. 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, a negative result is generated. The negative results are reported because they are essential when conducting statistical evaluations of data.

## RADIONUCLIDES OF ENVIRONMENTAL INTEREST

Several types of radionuclides are found in the environment at BNL due to historical operations and include the following:

### STRONTIUM-90

Strontium-90 is a beta-emitting radionuclide with a half-life of 28 years (i.e., after 28 years only one half of the activity from the original remains). It is found in the environment principally as a result of fallout from aboveground nuclear weapons testing. (Fallout refers to the deposition of radionuclides on soils and water bodies as a result of being dispersed high into the Earth's atmosphere during nuclear explosions.) Strontium-90 released in the 1950s and early 1960s is still present in the environment today due to its long half-life. Additionally, nations that were not signatories of the Nuclear Test Ban Treaty of 1963 have conducted tests that have contributed to the global strontium-90 inventory. This radionuclide was also released as a result of the 1986 Chernobyl accident in the former Soviet Union.

The data in this environmental report are reported by method of analysis. Because strontium-90 requires a unique method of analysis, it is reported as a separate parameter in the data tables. The level of sensitivity for detecting strontium-90 using state-of-the-art analysis methods is quite low (less than 1 pCi/L), which makes it possible to detect strontium-90 at levels that are indicative of the environmental sources described above.

### TRITIUM

Among the radioactive materials that are used or produced at BNL, tritium has received the most public attention. Tritium exists in nature and is formed when cosmic radiation from space interacts with the gaseous nitrogen in the Earth's upper atmosphere. Approximately 4 million Ci (1.5E5 TBq) per year are produced in the atmosphere in this way, with the total global quantity being about 70 million Ci (2.6E6 TBq) at any given time (NCRP 1979). As a result of the 1950s and early 1960s aboveground weapons testing program, 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 exit signs and wrist watches (exit signs may contain as much as 25 Ci [925 GBq] of tritium). It 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.

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 kBq/L) (NCRP 1979). Approximately the same concentration was measurable in precipitation. Today, the level of tritium in surface waters in New York State is below 200 pCi/L (7.4 kBq/L) (NYSDOH 1993), 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. This beta radiation has a very low energy when compared to the emissions of most other radioactive elements. The body's outer layer of dead skin cells easily stops tritium beta radiation and therefore, only when taken into the body, can tritium cause an exposure. Because of its low energy radiation and short residence time in the body, the health threat posed by tritium is very small for most credible exposures.

Environmental tritium is found in two forms: (1) gaseous elemental tritium and (2) tritiated water (or water vapor), in which at least one of the hydrogen atoms in the $H_2O$ water molecule has been replaced by a tritium atom (hence, its shorthand notation HTO). All tritium released from BNL sources is in the form of HTO.

### CESIUM-137

Cesium-137 is a man-made, fission-produced radionuclide with a half-life of 30 years. It is found in the environment as a result of past aboveground nuclear weapons testing and can be observed in the upper levels of environmental soils at very low concentrations, usually less than 1 pCi/g (0.04 Bq/g). It is a beta-emitting radionuclide, but can be detected by gamma spectroscopy by the gamma emissions of its decay product, barium-137m.

**SCIENTIFIC NOTATION**

Since many of the numbers used in measurement and quantification in this report are either very large or very small, many zeroes would be required to express their value. Because this is inconvenient, scientific notation is used as a kind of numerical shorthand. Scientific notation is based on the principle of representing numbers in multiples of ten. For example, the number one million could be written as 1,000,000. Alternatively, this number could be written in scientific notation as $1 \times 10^6$. That is, "one times ten raised to the sixth power." Since even this shorthand can be cumbersome, it can be reduced even further by using the capital letter E to stand for $10^x$, or "ten raised to the power of some value x." Using this notation, 1,000,000 would be represented as 1E+06. Scientific notation is also used to represent very small numbers like 0.0001, which can be written as $1 \times 10^{-4}$ or 1E-04. This notation is used in the text and some tables in this report.

**PREFIXES**

Another method of representing very large or very small numbers without the use of many zeroes is to use prefixes to represent multiples of ten. For example, the prefix "milli" means that the value being represented is one thousandth of a whole unit, so that one-milligram is equal to one thousandth of a gram.

**DEFINITION OF RADIOLOGICAL TERMS**

Radiological terms are used throughout this report where radiation and radioactive material are discussed. The definitions of commonly used radiological terms are found in Appendix A.

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NCRP. 1987. *Ionizing Radiation Exposure of the Population of the United States*. NCRP Report No. 93. National Council on Radiation Protection and Measurements. Bethesda, Maryland.

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APPENDIX C:

# *Radiological Data Methodologies*

### DOSE CALCULATION - ATMOSPHERIC RELEASE PATHWAY

The effective dose equivalent for low-levels of airborne radioactive materials dispersed into the environment was calculated for each of the 16 compass sectors using the CAP88-PC, version 2.0 dose model program (EPA 1992). Site meteorology data were used to calculate annual dispersions for the midpoint of a given sector and distance. Facility-specific radionuclide release rates (in curies per year [Ci/yr]) were also used. All annual site boundary and collective dose values were generated using the CAP88-PC computer code, which calculates the total dose due to contributions from the immersion, inhalation, and ingestion pathways. The dose and risk estimates were based on low levels of chronic intake of radionuclides.

### DOSE CALCULATION - FISH INGESTION PATHWAY

To estimate the effective dose equivalent from the fish consumption pathway, the following procedure was used:

*Intake.*

The average fish consumption for an individual engaged in recreational fishing in the Peconic River was based on a study done by the New York State Department of Health (NYSDOH 1996), which estimates the consumption rate at approximately 15 pounds (7 kg) per year.

*Activity in Flesh.*

Radionuclide data for fish samples were all converted to picocuries per gram (pCi/g) wet weight, since this is the form in which the fish are caught and consumed.

*Dose Factor.*

DOE Order 5400.5 (1990) 50-year committed dose equivalent factors (in rem per microcurie [rem/μCi] intake) were applied. The committed dose equivalent factor for Cs-137 is 5.0E-02 rem/μCi.

*Calculation:*

*Dose* (rem/yr) = *Intake* (kg/year)
× *Activity in Flesh* (μCi/kg)
× *Dose Factor* (rem/μCi)

### DOSE CALCULATION - DEER MEAT CONSUMPTION

This calculation is performed in exactly the same way as shown in the previous section. The same DOE Order 5400.5 dose conversion factors are used. The only change is the estimate of total pounds ingested during the course of a year. For deer meat, the consumption rate of 64 pounds (29 kg) per year is based on the Environmental Protection Agency *Exposure Factors Handbook* (EPA 1996).

### RADIOLOGICAL DATA PROCESSING

Radiation events occur in a random fashion such that if a radioactive sample is counted multiple times, a distribution of results will be obtained. This spread, known as a Poisson distribution, will be centered about a mean value. If counted multiple times, the background activity of the instrument (the number of radiation events observed when no sample is present) will also be seen to have a distribution of values centered about a mean. The goal of a radiological analysis is to determine whether the sample in question contains activity in excess of the instrument or method blank background. Since the activity of the sample and the background are both Poisson distributed, subtraction of background activity from the measured sample activity results in a value that may 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 the sample contains activity that is truly greater than the instrument background.

Identifying a sample as containing activity greater than background, when it actually does not have activity present, is known as a Type I error. As with most laboratories, the BNL Analytical Services Laboratory sets its acceptance of a Type I error at 5% 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% 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 validated or verified radiological data are reported, regardless of their value.

At very low sample activity levels that are close to the instrument background, it is possible to obtain a sample result that is less than the 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 average (mean) value result. Subsequent analysis may produce a sample net result that is positive. All results must 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 Procedure,* NCRP Report No. 58 (NCRP 1985), and the *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance,* DOE/EH-0173T (1991). Typical MDLs for the various analyses performed on environmental and effluent samples are shown in Tables C-1, C-2, and C-3.

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% confidence interval, is determined by multiplying the population standard deviation of the mean by the $t_{(0.05)}$ statistic.

**Table C-1. Typical Minimum Detection Limits for Gross Activity and Tritium Concentrations in Water.**

| **Analysis** | **Aliquot** (mL) | **MDL** (pCi/L) |
|---|---|---|
| Gross alpha | 100 | 4 |
| | 200 | 1 |
| Gross beta | 100 | 9 |
| | 200 | 2 |
| Tritium | 1 | 3,900 |
| | 7 | 350 |

**Table C-2. Typical Minimum Detection Limits for Gamma Spectroscopy Analysis.**

| **Nuclide** | **300 g Soil** (μCi/mL) | **300 mL Water** (μCi/mL) | **3L Maranelli** (μCi/mL) |
|---|---|---|---|
| Be-7 | 7E-08 | 1E-07 | 1E-08 |
| Na-22 | 9E-09 | 1E-08 | 1E-09 |
| K-40 | 2E-07 | 2E-07 | 2E-08 |
| Sc-48 | 1E-08 | 1E-08 | 3E-08 |
| Cr-51 | 8E-08 | 1E-07 | 1E-08 |
| Mn-54 | 8E-09 | 1E-08 | 1E-09 |
| Mn-56 | 2E-07 | 3E-07 | 2E-08 |
| Co-57 | 7E-09 | 9E-09 | 1E-09 |
| Co-60 | 1E-08 | 1E-08 | 1E-09 |
| Zn-65 | 2E-08 | 2E-08 | 2E-09 |
| Cs-134 | 1E-08 | 1E-08 | 1E-09 |
| Cs-137 | 9E-09 | 1E-08 | 1E-09 |
| Ra-226 | 3E-08 | 3E-08 | 4E-08 |
| Th-228 | 2E-08 | 3E-08 | 1E-07 |
| Br-82 | 1E-08 | 2E-08 | 8E-08 |
| I-131 | 9E-09 | 1E-08 | 3E-09 |
| I-133 | 1E-08 | 2E-08 | 3E-09 |

Note: All MDLs shown above are approximate. For gamma spectroscopy, the MDL of the analysis is dependent upon several variables, such as the efficiency of the particular detector and the activity of the sample. These factors will vary between analyses and instrumentation.

**Table C-3. Typical Minimum Detection Limits for Chemical Analyses by BNL Analytical Services Lab and Offsite Analytical Laboratory.**

| **Constituent** | **BNL Laboratory** | **Offsite Laboratory** |
|---|---|---|
| Ag | 0.025 | 0.010 |
| Cd | 0.0005 | 0.005 |
| Cr | 0.005 | 0.010 |
| Cu | 0.050 | 0.025 |
| Fe | 0.075 | 0.100 |
| Hg | 0.0002 | 0.0002 |
| Mn | 0.050 | 0.015 |
| Na | 1.0 | 5.0 |
| Pb | 0.005 | 0.003 |
| Zn | 0.02 | 0.020 |
| Ammonia-N | NA | 0.02 |
| Nitrite-N | NA | 0.01 |
| Nitrate-N | 1.0 | NA |
| Specific Conductance | 10 mmhos/cm | NA |
| Chlorides | 4.0 | NA |
| Sulfates | 4.0 | NA |
| 1,1,1-trichloroethane | 0.002 | 0.005 |
| trichloroethylene | 0.002 | 0.005 |
| tetrachloroethylene | 0.002 | 0.005 |
| chloroform | 0.002 | 0.005 |
| chlorodibromomethane | 0.002 | 0.005 |
| bromodichloromethane | 0.002 | 0.005 |
| bromoform | 0.002 | 0.005 |
| benzene | 0.002 | 0.005 |
| toluene | 0.002 | 0.005 |
| xylene | 0.002 | 0.005 |

Notes:
All concentrations in mg/L except where noted.
NA = Not Applicable (Laboratory does not perform analysis for constituent)

REFERENCES

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# *Instrumentation and Analytical Methods*

The Analytical Services Laboratory (ASL) is divided into radiological and nonradiological sections to facilitate analysis of specific parameters in each category. The methods and instrumentation for each category are briefly described below. Only validated and regulatory referenced methods were used during the analysis. All samples were collected and preserved by trained technicians according to appropriate referenced methods. Qualified, and trained analysts performed each of the different analyses.

## RADIOLOGICAL ANALYTICAL METHODS

The ASL is certified by New York State Department of Health (NYSDOH) for gross alpha, gross beta, gamma, tritium and strontium-90 (non-potable water). The following is a description of the radiological analytical methods.

### GROSS ALPHA AND GROSS BETA ANALYSIS - WATER MATRIX - EPA 900.0

Water samples are collected in four-liter polyethylene containers by BNL sampling teams and preserved at the time of collection by acidification to pH 2 using nitric acid. Effluent or surface stream samples of 100 ml are extracted for analysis. Groundwater samples are typically analyzed using a 200-mL aliquot. The aliquot is evaporated to near-dryness in a glass beaker. Two drops of concentrated nitric acid are added after which the solids are policed down the side of the beaker. The sample is transferred to a stainless steel planchet. Four drops of 10% Triton-X are added to the sample before it completely evaporates on a hot plate. The planchets are placed in a drying oven at 105°C for a minimum of 2 hours; removed to a desiccator and allowed to cool; weighed and counted in a gas-flow proportional counter for 50 minutes. Groundwater samples are counted for 200 minutes. Samples are normally processed in batch mode. The first sample of each batch is a background, for which the count rate is subtracted from the raw data before computing net activity concentration. System performance is checked daily with NIST-traceable standards: americium-241 for alpha, and strontium-90 for beta. Spiked duplicates are performed within each batch of samples to determine precision and accuracy.

### GROSS ALPHA AND GROSS BETA ANALYSIS - AIR PARTICULATE MATRIX

Air particulate samples are collected on 50-mm glass fiber filters at a nominal flow rate of 15 liters per minute. At the end of the collection, the filters are returned to the analytical laboratory for assay. After a one week holding time, filters are counted once in a gas flow proportional counter for 50 minutes. This delay permits the short-lived radon/thoron daughters to decay. The first sample of each batch is a blank filter whose count rate is subtracted from the raw data before calculating net activity concentration. The system's performance is checked daily with National Institute for Standards and Technology (NIST) traceable standards: americium-241 for alpha and strontium-90 for beta.

### TRITIUM ANALYSIS - WATER MATRIX - EPA 906.0

Water samples are collected in glass containers. No preservatives are added before collecting the sample. Effluent and surface stream samples as well as groundwater samples are analyzed using a 7-mL aliquot. Potable-water samples (as well as other samples requiring a low minimum detection limit) are distilled following the method outlined in EPA Method 906.0 (EPA 1980) and a 7-mL aliquot is analyzed. Liquid scintillation cocktail is added to the aliquot so that the final volume in the liquid-scintillation-counting vial is 7 mL of sample plus 10 ml of cocktail. Samples then are counted in a low-background liquid-scintillation counter for 50 minutes. Samples are normally processed in batch mode. The first sample of each batch is a steam-distilled water background that is subtracted from the raw data before calculating the net activity concentration. The second sample in each batch is a NIST-traceable tritium standard, which is used to verify the system's performance and efficiency. Each sample is also monitored for quenching.

Corrections for background, quenching, and efficiency of the sample matrix are factored into the final net concentrations for each sample. Spiked duplicates are performed within each batch of samples to determine precision and accuracy.

#### TRITIUM ANALYSIS - AIR MATRIX

Concentration of tritium in ambient and facility air is measured by drawing the air through a desiccant at a rate of approximately 200 cc/min. At the end of each collection period, typically one week, the desiccant is brought to the analytical laboratory for processing. It is heated in a glass manifold system. Dedicated glassware are used for environmental samples. The desiccant, containing moisture from the sampled air, is heated using an electric mantle, and the evaporated moisture is condensed by a water-cooled glass condenser. The total volume of water collected is determined gravimetrically. A 7-mL aliquot of this water is then assayed for tritium content. If the desiccant contains less than 7-mL of condensed liquid, a 1-ml aliquot is used. Liquid scintillation cocktail is then added to the aliquot so that the final volume in the counting vial is 17-mL. Samples are then counted in a low-background liquid-scintillation counter for 50 minutes. If a 1-mL aliquot was used, liquid scintillation cocktail is added to the vial so that the final volume is 11-mL. These samples are counted for 100 minutes. Samples are normally processed in batch mode. The first sample of each batch is a steam-distilled water background whose count rate is subtracted from the raw data before computing net activity concentration. The second sample in each batch is a NIST-traceable tritium standard, which is used to verify the system's performance and efficiency. Each sample is also monitored for quenching. Corrections for background, water recovery, air sample volume, quenching and efficiency for the sample matrix are factored into the final net concentrations for each sample. Spiked duplicates are performed within each batch of samples to determine precision and accuracy, respectively.

#### STRONTIUM-90 ANALYSIS

Strontium-90 analyses are currently performed on water. Groundwater samples are processed inhouse using either DOE Method RP500, which utilizes a crown ether to selectively separate strontium from the acidified sample matrix or an ion exchange resin method. The strontium is eluted from the resin or filtration disk using dilute nitric acid. The resulting eluent is evaporated on a 5 cm stainless steel planchet and the sample counted in a gas-flow proportional counter. Samples are prepared in batches, including a standard and a method blank in each batch. Chemical recovery is determined for each sample by the recovery of strontium carbonate. NIST-traceable strontium-90 standards are used to calibrate and verify the performance of the counting instrument. Samples are counted once after a 2 week radiological in-growth time.

Potable water samples as well as samples of solids are shipped to a contractor laboratory, which is certified to perform the EPA (1980), 905.0 method for strontium-90 in drinking water. This method employs time-consuming and costly wet-chemistry techniques to isolate strontium from the sample. Samples are counted twice to verify strontium-90 and yttrium-90 in-growth. Samples are typically processed in a batch. Backgrounds and system performance are verified with each batch. Chemical recoveries are determined by either gravimetric or gamma emitting strontium-85 standard addition techniques.

#### GAMMA SPECTROSCOPY ANALYSIS – EPA 901.1

Surface, potable, and groundwater surveillance samples are typically of 4 liters and are placed in polyethylene bottles acidified to pH 2 with nitric acid. Samples are then measured into a 4-L Marinelli™ beaker and counted on a calibrated gamma spectroscopy detector for 50,000 seconds. Air-particulate filters and air-charcoal canisters are counted directly on the calibrated gamma spectroscopy detector for 10,000 seconds. Soil, vegetation, and aquatic biota are all processed following collection. Typically, a 100-, 200- or 300-gram aliquot is taken, placed in a Teflon-lined aluminum can and directly counted. For gamma spectroscopy analyses, overnight backgrounds are counted once per week, with calibration and background checked daily. Analytical results reflect net activity that has been corrected for background and efficiency for each counting geometry used.

### NONRADIOLOGICAL ANALYTICAL METHODS

The ASL is certified by NYSDOH ELAP for purgeable aromatics, purgeable halocarbons, PCBs, anions, and metal compounds, in both potable and wastewater matrices, using EPA 524, EPA 624, EPA 200.8, EPA 245.2, EPA 236.1, EPA 273.1 and EPA 300.0

**Table D-1. ASL Certified Organic Analytes.**

| EPA 624 Analytes | | | |
|---|---|---|---|
| Bromoform | 1,1-Dichloroethane | Trichloroethene | 1,1,2-Trichloroethane |
| Chloromethane | 2-Butanone | 1,2-Dichloropropane | Tetrachloroethene |
| Vinyl Chloride | Chloroform | Bromodichloromethane | 2-Hexanone |
| Bromomethane | 1,1,1-Trichloroethane | 1,1,2,2-Tetrachloroethane | Dibromochloromethane |
| Chloroethane | Dibromofluoromethane | 4-Methyl-2-pentanone | MTBE |
| Trichlorofluoromethane | Carbon Tetrachloride | cis-1,3-Dichloropropene | Chlorobenzene |
| 1,1-Dichloroethene | Benzene | p-Bromofluorobenzene | Ethylbenzene |
| Acetone | 1,2-Dichloroethane | Toluene | m\p-xylene |
| Methylene Chloride | All Dichlorobenzenes | trans-1,3-Dichloropropene | o-Xylene |
| trans-1,2-Dichloroethene | | | |
| **EPA 524 Analytes** | | | |
| Dichlorodifuoromethane | Chloroform | 1,1,2-Trichloroethane | 4-Chlorotoluene |
| Chloromethane | 1,1,1-Trichloroethane | Tetrachloroethene | Tertbutylbenzene |
| Vinyl Chloride | Carbon Tetrachloride | m,p-xylene | 1,2,4-trimethylbenzene |
| Bromomethane | 1,1-Dichloropropene | 1,3-dichloropropane | sec-Butylbenzene |
| Chloroethane | Benzene | Dibromochloromethane | p-Isopropyltoluene |
| Trichlorofluoromethane | 1,2-Dichloroethane | 1,2-dibromoethane | n-Butylbenzene |
| 1,1-Dichloroethene | o-Xylene | 1,1,1,2-Tetrachloroethane | 1,3-Dichlorobenzene |
| Chlorobenzene | Trichloroethene | Bromoform | 1,4-Dichlorobenzene |
| Methylene Chloride | 1,2-Dichloropropane | Isopropylbenzene | 1,2-Dichlorobenzene |
| trans-1,2-Dichloroethene | Dibromomethane | Bromobenzene | 1,2-Dibromo-3-Cl-propane |
| 1,1-Dichloroethane | Bromodichloromethane | 1,1,2,2-Tetrachloroethane | 1,2,4-Trichlorobenzene |
| 2,2-Dichloropropane | cis-1,3-Dichloropropene | n-Propylbenzene | Hexachlorobutadiene |
| cis-1,2-Dichloroethene | Styrene | 1,2,3-Trichloropropane | Naphthalene |
| Bromochloromethane | Toluene | 2-Chlorotoluene | 1,2,3-trichlorobenzene |
| Ethylbenzene | Trans-1,3-Dichloropropene | 1,3,5-trimethylbenzene | |

methods. Tables D-1 and D-2 list the non-radiological organic and inorganic NYSDOH ELAP certified analytes, respectively.

### PURGEABLE AROMATICS AND PURGEABLE HALOCARBONS

Water samples are collected in 40 mL glass vials with removable teflon-lined caps without any headspace, and acidified 1:1 HCl to pH <2.0. Samples are stored at 4°C and analyzed within 14 days. Thirty eight purgeable compounds (including: benzene, toluene, ethyl benzene, total xylenes, chloroform, 1,1-dichloroethane, 1,1-dichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene, chlorobenzene, carbon tetrachloride, methyl chloride and acetone) are analyzed under this category following EPA Method 624 protocols using Gas Chromatography/Mass Spectrometry (GC/MS). There are currently two Hewlett-Packard™ GC/MS instruments used to analyze purgeable organic compounds. Since groundwater under BNL is classified as a sole source aquifer under the Safe Drinking Water Act and Class GA groundwater by the New York State Department of Environmental Conservation (NYSDEC), the detection limits reported for the compounds are close to NYS drinking water standards and the ambient water

**Table D-2. ASL Certified Metals and Anions.**

| Metals | Instrument | Method |
|---|---|---|
| Aluminum | ICP/MS | EPA 200.8 |
| Antimony | ICP/MS | EPA 200.8 |
| Arsenic | ICP/MS | EPA 200.8 |
| Barium | ICP/MS | EPA 200.8 |
| Beryllium | ICP/MS | EPA 200.8 |
| Cadmium | ICP/MS | EPA 200.8 |
| Chromium | ICP/MS | EPA 200.8 |
| Cobalt | ICP/MS | EPA 200.8 |
| Copper | ICP/MS | EPA 200.8 |
| Iron | AAS | EPA 236.1 |
| Lead | ICP/MS | EPA 200.8 |
| Manganese | ICP/MS | EPA 200.8 |
| Mercury | AAS | EPA 245.2 |
| Molybdenum | ICP/MS | EPA 200.8 |
| Nickel | ICP/MS | EPA 200.8 |
| Selenium | ICP/MS | EPA 200.8 |
| Silver | ICP/MS | EPA 200.8 |
| Sodium | AAS | EPA 273.1 |
| Thallium | ICP/MS | EPA 200.8 |
| Vanadium | ICP/MS | EPA 200.8 |
| Zinc | ICP/MS | EPA 200.8 |
| **Anions** | **Instrument** | **Method** |
| Chloride | IC | EPA 300.0 |
| Nitrate | IC | EPA 300.0 |
| Sulfate | IC | EPA 300.0 |

Notes:
ICP/MS = Inductively Coupled/Mass Spectrometry
AAS = Atomic Absorption Spectrometry
IC = Ion Chromatography

quality standard. EPA drinking water Methods 524.2 and 624 are used to analyze water, based on the project manager's data quality requirements.

The method involves purging a 25-mL aliquot of the sample with ultra pure helium in a specially designed sparger using the Purge and Trap technique. Each sample is spiked with a known concentration of internal standards and surrogates before purging to facilitate identifying, quantifying and determining the extraction efficiency of analytes from the matrix. The purged analytes are trapped onto a specially designed trap and thermally desorbed on to the capillary chromatographic column by back flushing the trap with helium. Individual compounds are separated with a temperature program of the GC and enter the mass spectrometer where they undergo fragmentation to give characteristic mass spectra. The unknown compounds are identified by comparing their mass spectra and retention times with reference compounds and quantified by internal standard method. The quantitation data is supported by extensive Quality Assurance/Quality Control, such as tuning the mass spectrometer to meet bromofluorobenzene criteria, initial and continuing calibrations verifying daily response factors, method blanks, surrogate recoveries, duplicate analysis, matrix spike and matrix spike duplicate analysis, and reference standard analysis to verify the daily working standard.

#### PCB ANALYSIS

The ASL is NYSDOH Certified for PCB Aroclors 1016, 1221, 1232, 1242, 1248, 1254 and 1260. Samples are collected in 50-100 mL glass containers with Teflon™-lined lid and stored at 4°C and analyzed within 30 days. Transformer oil, mineral oil, hydraulic fluid, waste oil and spill wipe-samples are analyzed for PCBs using gas chromatography-dual electron capture detector (GC-ECD) method. This method is similar to EPA SW-846 Method 8082 and is targeted to identify and quantify seven different mixtures of PCB congeners in samples.

The method consists of diluting a known weight of the sample with isooctane and removing the interfering compounds with one or more aliquots of concentrated sulfuric acid till the acid layer is almost colorless. The entire oil matrix, along with other interfering polar compounds, is selectively removed from the sample, leaving the PCBs in isooctane solvent.

There is currently a single GC-ECD instrument for analyzing PCB. The PCBs found in the samples are identified and quantified by comparing the retention times and chromatographic patterns with the standards. Methods blanks, duplicates, spikes, calibration and reference check standards are run as part of Quality Assurance/Quality Control.

#### ANIONS

Chloride, nitrate-N, and sulfate are analyzed using Dionex Ion-chromatography (IC) with ion suppression and conductivity detection technique. Samples from monitoring wells are collected in 100-mL polyethylene bottles, cooled to 4°C, and analyzed within 28 days. For nitrate in drinking water analysis, samples are analyzed within 48 hrs. Holding times were exceeded for nitrate analysis of some nonpotable monitoring well samples, but the depletion of nitrate is expected to be negligible.

The anions are passed through an anion-exchange polymer column and eluted with carbonate/bicarbonate solution. Then the eluent passes through a membrane suppressor, where the background contribution from the eluent is suppressed, improving signal to noise ratio (and detection limits). The target anions are then detected by conductivity meter.

Initially, the system is calibrated with standards to define its working range. The target anions in the samples are identified and quantified by comparing the retention times and areas with the standards. Method blanks, duplicates, replicates, spikes, and reference standards are routinely analyzed as part of Quality Assurance/Quality Control.

#### METALS

Samples are collected in 500-mL glass bottles and stabilized with ultra-pure nitric acid to a pH of <2. The samples are analyzed within 6 months, except for mercury, which is analyzed within 26 days.

Iron and sodium are analyzed with a Perkin-Elmer atomic absorption spectrometer. Using the flame technique, the sample containing the target element is nebulized and atomized in an oxy-acetylene flame. At the same time, a beam of light from an element-specific hollow cathode lamp corresponding to the absorption frequency of target element is passed through the flame. The atomized element absorbs the energy specific to that element from the cathode lamp and the intensity of absorption is proportional to the concentration of the element in the sample. Calibration curves establish the linearity of the system and samples are quantified by comparing with standards.

Fourteen of the seventeen elements offered for certification in potable water by

NYSDOH ELAP are analyzed by Inductively Coupled Plasma/Mass Spectrometry (ICP/MS). Iron and sodium are detailed in the preceding paragraph, and mercury in the following. Including aluminum, cobalt, molybdenum and vanadium, for which only wastewater certification is available, there are eighteen elements analyzed by the ICP/MS technique. Aqueous samples are nebulized, and introduced into a radio frequency argon plasma, at temperatures reaching 8000°K. The de-solvated, atomized analytes are ionized to predominantly singly-charged cations which are identified and quantified by the use of a quadrupole mass spectrometer. Isobaric and polyatomic ion interferences are corrected using elemental interference equations based on natural isotopic abundances. Internal standardization eliminates or minimizes instrument drift and matrix induced signal suppressions and enhancements. Using this technique, sub-part per billion sample detection limits are achievable.

Using a cold-vapor technique for mercury, a 100-mL aliquot of the sample is digested with potassium permanganate/persulfate oxidizing solution at 95°C for 2 hours to oxidize any organically bound and/or monovalent mercury to mercury (II) oxidation state. Excess oxidizing agent is destroyed with hydroxylamine hydrochloride. The mercuric ion later is reduced to elemental mercury with excess stannous chloride, which is purged with argon into the absorption cell. The absorption is directly proportional to the concentration of mercury in the sample. All the atomic absorption techniques involve initial calibrations to define the calibration range, continuing calibrations, method blanks, duplicates, replicates, matrix spikes, and reference standard analysis as a part of Quality Assurance/Quality Control.

In the fall of 2000, a Leeman PS 200 II automated mercury analyzer was added. This unit enables improved detection limits (<0.1 µg/L), and a more stable baseline than previous instrumentation. This has resulted in improved data quality.

## REFERENCES

DOE. 1995. *Methods for Evaluating Environmental and Waste Management Samples*. DOE/EM 0089T. U.S. Department of Energy. Washington, D.C.

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NYSDEC. 1995. *Analytical Services Protocols*. Bureau of Technical Services and Research, New York State Department of Environmental Conservation. Albany, New York. October 1995.

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# *Groundwater Monitoring Wells List for 2000*

ER=Environmental Restoration Program ES=Environmental Surveillance

## OU I - HWMF/Current Landfill (RA-V)

| | | | | | | |
|---|---|---|---|---|---|---|
| 077-02 ER | 098-21 ER | 098-62 ER | 107-26 ER | 108-30 ER | 115-29 ER | 116-06 ER |
| 087-21 ER | 098-22 ER | 098-63 ER | 108-08 ER | 115-03 ER | 115-30 ER | 000-124 ER |
| 088-13 ER | 098-30 ER | 099-04 ER | 108-12 ER | 115-13 ER | 115-31 ER | 000-137 ER |
| 088-14 ER | 098-33 ER | 107-10 ER | 108-13 ER | 115-14 ER | 115-36 ER | 000-138 ER |
| 088-20 ER | 098-58 ER | 107-23 ER | 108-14 ER | 115-15 ER | 115-41 ER | 800-54 ER |
| 088-26 ER | 098-59 ER | 107-24 ER | 108-17 ER | 115-16 ER | 115-42 ER | |
| 098-19 ER | 098-61 ER | 107-25 ER | 108-18 ER | 115-28 ER | 116-05 ER | |

**Total 47**

## OU I Current Landfill Post-Closure

| | | | | | | |
|---|---|---|---|---|---|---|
| 087-09 ER | 087-23 ER | 087-26 ER | 088-21 ER | 088-23 ER | 088-109 ER | 088-110 ER |
| 087-11 ER | 087-24 ER | 087-27 ER | 088-22 ER | | | |

**Total 11**

## OU I Former Landfill Post-Closure

| | | | | | | |
|---|---|---|---|---|---|---|
| 086-42 ER | 087-22 ER | 097-17 ER | 097-64 ER | 097-277 ER | 106-02 ER | 106-30 ER |
| 086-72 ER | | | | | | |

**Total 8**

## Chemical/Animal Holes Area

| | | | | | | |
|---|---|---|---|---|---|---|
| 106-04 ER | 106-16 ER | 106-22 ER | 106-43 ER | 106-46 ER | 106-49 ER | 106-63 ER |
| 106-13 ER | 106-17 ER | 106-23 ER | 106-44 ER | 106-47 ER | 106-50 ER | 106-64 ER |
| 106-14 ER | 106-20 ER | 106-24 ER | 106-45 ER | 106-48 ER | 106-62 ER | 114-01 ER |
| 106-15 ER | 106-21 ER | 106-25 ER | | | | |

**Total 24**

## AGS

| | | | | | | |
|---|---|---|---|---|---|---|
| 054-07 ES | 054-67 ES | 054-128 ES | 055-30 ES | 064-53 ES | 065-120 ES | 065-126 ES |
| 054-08 ES | 054-68 ES | 054-129 ES | 055-31 ES | 064-54 ES | 065-121 ES | 065-192 ES |
| 054-62 ES | 054-69 ES | 054-130 ES | 055-32 ES | 064-55 ES | 065-122 ES | 065-193 ES |
| 054-63 ES | 054-124 ES | 055-14 ES | 064-01 ES | 064-56 ES | 065-123 ES | 065-194 ES |
| 054-64 ES | 054-125 ES | 055-15 ES | 064-03 ES/ER | 064-52 ES | 065-124 ES | 065-195 ES |
| 054-65 ES | 054-126 ES | 055-16 ES | 064-51 ES | 065-120 ES | 065-125 ES | |
| 054-66 ES | 054-127 ES | 055-29 ES | 065-52 ES | | | |

**Total 45**

## RHIC

| | | | | | | |
|---|---|---|---|---|---|---|
| 025-02 ES | 025-04 ES | 025-06 ES | 025-08 ES | 034-06 ES | 043-02 ES | 044-14 ES |
| 025-03 ES | 025-05 ES | 025-07 ES | 034-05 ES | 043-01 ES | 044-13 ES | |

**Total 13**

## BLIP

| | | | | | | |
|---|---|---|---|---|---|---|
| 054-61 ES | 064-02 ES | 064-46 ES | 064-47 ES | 064-48 ES | 064-49 ES | 064-50 ES |

**Total 7**

## New Waste Management Facility

| | | | | | | |
|---|---|---|---|---|---|---|
| 055-03 ES | 056-21 ES | 056-22 ES | 056-23 ES | 066-07 ES | 066-83 ES | 066-84 ES |
| 055-10 ES | | | | | | |

**Total 8**

## BMRR

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 084-12 ES | 084-13 ES | 084-27 ES | 084-28 ES | | | | |
| | | | | | | **Total** | **4** |

## HFBR and Remediation System

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 065-01 ER | 075-50 ER | 075-234 ER | 075-293 ER | 085-67 ER | 095-45 ER | 096-55 ER | |
| 065-37 ER | 075-85 ER | 075-235 ER | 075-294 ER | 085-68 ER | 095-46 ER | 096-82 ER | |
| 065-38 ER | 075-86 ER | 075-236 ER | 075-295 ER | 085-69 ER | 095-47 ER | 096-83 ER | |
| 065-39 ER | 075-87 ER | 075-237 ER | 076-171 ER | 085-70 ER | 095-48 ER | 096-84 ER | |
| 065-40 ER | 075-88 ER | 075-238 ER | 076-172 ER | 085-71 ER | 095-51 ER | 104-10 ER | |
| 065-41 ER | 075-89 ER | 075-239 ER | 076-173 ER | 085-72 ER | 095-52 ER | 104-11 ER | |
| 065-42 ER | 075-208 ER | 075-240 ER | 076-174 ER | 085-73 ER | 095-53 ER | 104-25 ER | |
| 075-11 ER | 075-209 ER | 075-241 ER | 076-175 ER | 085-74 ER | 095-54 ER | 105-07 ER | |
| 075-12 ER | 075-210 ER | 075-242 ER | 076-177 ER | 085-75 ER | 095-55 ER | 105-22 ER | |
| 075-39 ER | 075-211 ER | 075-243 ER | 077-10 ER | 085-76 ER | 095-87 ER | 105-23 ER | |
| 075-40 ER | 075-224 ER | 075-244 ER | 077-11 ER | 085-77 ER | 095-88 ER | 105-24 ER | |
| 075-41 ER | 075-225 ER | 075-245 ER | 085-01 ER | 085-78 ER | 095-89 ER | 105-29 ER | |
| 075-42 ER | 075-226 ER | 075-285 ER | 085-02 ER | 085-170 ER | 095-90 ER | 105-42 ER | |
| 075-43 ER | 075-228 ER | 075-286 ER | 085-39 ER | 085-171 ER | 095-91 ER | 105-43 ER | |
| 075-44 ER | 075-229 ER | 075-287 ER | 085-40 ER | 086-09 ER | 095-92 ER | 105-44 ER | |
| 075-45 ER | 075-230 ER | 075-288 ER | 085-41 ER | 095-42 ER | 095-93 ER | 113-08 ER | |
| 075-46 ER | 075-231 ER | 075-291 ER | 085-65 ER | 095-43 ER | 095-139 ER | 113-09 ER | |
| 073-47 ER | 075-232 ER | 075-292 ER | 085-66 ER | 095-44 ER | 095-140 ER | 113-11 ER | |
| 075-48 ER | 075-233 ER | | | | | | |
| | | | | | | **Total** | **128** |

## Live Fire Range

| | | | |
|---|---|---|---|
| 039-91 ES | 039-92 ES | | |
| | | **Total** | **2** |

## Shotgun Range

| | | | | |
|---|---|---|---|---|
| 046-01 ES | 046-02 ES | 046-03 ES | | |
| | | | **Total** | **3** |

## Water Treatment Plant Basin

| | | | | | | |
|---|---|---|---|---|---|---|
| 063-01 ES | 063-02 ES | 063-03 ES | 075-01 ES | 075-02 ES | **Total** | **5** |

## BNL Gasoline Station

| | | | | | | |
|---|---|---|---|---|---|---|
| 085-16 ES | 085-17 ES | 085-235 ES/ER | 085-236 ES/ER | 085-237 ES/ER | | |
| | | | | | **Total** | **5** |

## BNL Motor Pool

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 102-05 ES | 102-08 ES | 102-09 ES | 102-10 ES | 102-11 ES | 102-12 ES | 102-13 ES | |
| 102-06 ES | | | | | | | |
| | | | | | | **Total** | **8** |

## Biology Greenhouse Area

| | | | |
|---|---|---|---|
| 084-36 ES | 084-37 ES | | |
| | | **Total** | **2** |

## OU III - Central Sector

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 064-03 ER | 065-02 ER | 072-03 ER | 083-01 ER | 096-07 ER | 105-25 ER | 109-04 ER | |
| 065-02 ER | 065-05 ER | 072-04 ER | 083-02 ER | 105-05 ER | 106-19 ER | 113-06 ER | |
| 065-05 ER | 066-08 ER | 075-01 ER | 084-04 ER | 105-06 ER | 109-03 ER | 113-07 ER | |
| 064-08 ER | 066-09 ER | 075-02 ER | 084-05 ER | | | | |
| | | | | | | **Total** | **25** |

## OU III - Southern Boundary

| | | | | | | |
|---|---|---|---|---|---|---|
| 114-06 ER | 121-10 ER | 121-19 ER | 122-04 ER | 122-17 ER | 122-31 ER | 126-01 ER |
| 114-07 ER | 121-11 ER | 121-20 ER | 122-05 ER | 122-18 ER | 122-32 ER | 130-02 ER |
| 121-06 ER | 121-12 ER | 121-21 ER | 122-09 ER | 122-19 ER | 122-33 ER | 130-03 ER |
| 121-07 ER | 121-13 ER | 121-22 ER | 122-10 ER | 122-20 ER | 122-34 ER | 130-04 ER |
| 121-08 ER | 121-14 ER | 121-23 ER | 122-15 ER | 122-21 ER | 122-35 ER | |
| 121-09 ER | 121-18 ER | 122-02 ER | 122-16 ER | 122-22 ER | 124-02 ER | |
| | | | | | | **Total** **40** |

## OU III – Carbon Tetrachloride Plume

| | | | | | | |
|---|---|---|---|---|---|---|
| 085-07 ER | 085-17 ER/ES | 085-160 ER | 085-163 ER | 085-237 ER/ES | 085-238 ER | 086-114 ER |
| 085-13 ER | 085-98 ER | 085-162 ER | 085-236 ER/ES | 085-235 ER/ES | 086-113 ER | 095-183 ER |
| 085-16 ER/ES | 085-161 ER | | | | | |
| | | | | | | **Total** **16** |

## OU III – Building 96

| | | | | | | |
|---|---|---|---|---|---|---|
| 085-97 ER | 095-159 ER | 095-162 ER | 095-165 ER | 095-167 ER | 095-169 ER | 095-171 ER |
| 095-84 ER | 095-160 ER | 095-163 ER | 095-166 ER | 095-168 ER | 095-170 ER | 095-172 ER |
| 095-85 ER | 095-161 ER | 095-164 ER | | | | |
| | | | | | | **Total** **17** |

## OU III – Offsite

| | | | | | | |
|---|---|---|---|---|---|---|
| 000-97 ER | 000-101 ER | 000-105 ER | 800-21 ER | 800-40 ER | 800-44 ER | 800-52 ER |
| 000-98 ER | 000 102 ER | 000-107 ER | 800-22 ER | 800-41 ER | 800-50 ER | 800-53 ER |
| 000-99 ER | 000-104 ER | 000-131 ER | 800-23 ER | 800-43 ER | 800-51 ER | |
| | | | | | | **Total** **20** |

## OU III – Offsite Treatment Area

| | | | | | | |
|---|---|---|---|---|---|---|
| 000-112 ER | 000-248 ER | 000-254 ER | 000-260 ER | 000-266 ER | 000-271 ER | 000-276 ER |
| 000-114 ER | 000-249 ER | 000-255 ER | 000-261 ER | 000-267 ER | 000-272 ER | 000-277 ER |
| 000-130 ER | 000-250 ER | 000-256 ER | 000-262 ER | 000-268 ER | 000-273 ER | 000-278 ER |
| 000-245 ER | 000-251 ER | 000-257 ER | 000-263 ER | 000-269 ER | 000-274 ER | 000-279 ER |
| 000-246 ER | 000-252 ER | 000-258 ER | 000-264 ER | 000-270 ER | 000-275 ER | 000-280 ER |
| 000-247 ER | 000-253 ER | 000-259 ER | 000-265 ER | | | |
| | | | | | | **Total** **39** |

## OU III – BGRR/WCF Areas

| | | | | | | |
|---|---|---|---|---|---|---|
| 065-03 ER | 065-39 ER | 065-167 ER | 065-175 ER | 075-41 ER | 075-189 ER | 075-197 ER |
| 065-04 ER | 065-40 ER | 065-168 ER | 065-176 ER | 075-46 ER | 075-190 ER | 075-198 ER |
| 065-06 ER | 065-160 ER | 065-169 ER | 065-177 ER | 075-47 ER | 075-191 ER | 075-199 ER |
| 065-11 ER | 065-161 ER | 065-170 ER | 065-178 ER | 075-48 ER | 075-192 ER | 075-200 ER |
| 065-18 ER | 065-162 ER | 065-171 ER | 075-09 ER | 075-85 ER | 075-193 ER | 075-201 ER |
| 065-19 ER | 065-163 ER | 065-172 ER | 075-10 ER | 075-86 ER | 075-194 ER | 075-202 ER |
| 065-20 ER | 065-164 ER | 065-173 ER | 075-39 ER | 075-87 ER | 075-195 ER | 075-203 ER |
| 065-37 ER | 065-165 ER | 065-174 ER | 075-40 ER | 075-188 ER | 075-196 ER | |
| 065-38 ER | 065-166 ER | | | | | **Total** **57** |

## SCWA Onsite Sentinel Wells - Wm. Floyd Well Field

| | |
|---|---|
| 109-03 ER | 109-04 ER |
| | **Total** **2** |

## OU IV - Central Steam Facility

| | | | | | | |
|---|---|---|---|---|---|---|
| 076-02 ER | 076-05 ER | 076-09 ER | 076-22 ER | 076-179 ER | 076-182 ER | 076-185 ER |
| 076-24 ER | 076-06 ER | 076-19 ER | 076-23 ER | 076-180 ER | 076-183 ER | 076-186 ER |
| 076-04 ER | 076-07 ER | 076-21 ER | 076-178 ER | 076-181 ER | 076-184 ER | |
| | | | | | | **Total** **20** |

## OU IV – Building 650 Outfall

| | | | | | | |
|---|---|---|---|---|---|---|
| 066-17 ER | 076-07 ER | 076-22 ER | 076-27 ER | 076-169 ER | 076-184 ER | 076-265 ER |
| 066-18 ER | 076-09 ER | 076-24 ER | 076-28 ER | 076-181 ER | 076-262 ER | 076-314 ER |
| 066-189 ER | 076-10 ER | 076-25 ER | 076-167 ER | 076-182 ER | 076-263 ER | 076-317 ER |
| 066-190 ER | 076-13 ER | 076-26 ER | 076-168 ER | 076-183 ER | 076-264 ER | 076-373 ER |
| 076-05 ER | 076-20 ER | | | | | |
| | | | | | **Total** | **30** |

## Major Petroleum Facility

| | | | | | | |
|---|---|---|---|---|---|---|
| 076-25 ES/ER | 076-17 ES | 076-18 ES | 076-19 ES | 076-378 ES | 076-379 ES | 076-380 ES |
| 076-16 ES | | | | | | |
| | | | | | **Total** | **8** |

## OU I/IV- Southern Plumes

| | | | | | | |
|---|---|---|---|---|---|---|
| 000-108 ER | 000-212 ER | 086-43 ER | 106-55 ER | 115-32 ER | 122-24 ER | 800-60 ER |
| 000-153 ER | 000-213 ER | 086-70 ER | 106-56 ER | 115-33 ER | 122-25 ER | 800-63 ER |
| 000-154 ER | 000-215 ER | 106-53 ER | 106-58 ER | 115-34 ER | 800-59 ER | |
| 000-211 ER | 086-05 ER | 106-54 ER | 106-59 ER | 115-35 ER | | |
| | | | | | **Total** | **25** |

## OU V - Sewage Treatment Plant & Offsite Plume

| | | | | | | |
|---|---|---|---|---|---|---|
| 037-02 ER | 039-07 ES | 041-01 ER | 060-01 ER | 000-142 ER | 600-15 ER | 600-22 ER |
| 037-03 ER | 039-08 ES | 041-02 ER | 061-03 ER | 000-143 ER | 600-16 ER | 600-23 ER |
| 037-04 ER | 039-86 ES | 041-03 ER | 061-04 ER | 000-144 ER | 600-18 ER | 600-24 ER |
| 038-02 ES | 039-87 ES | 049-05 ER | 061-05 ER | 000-145 ER | 600-19 ER | 600-25 ER |
| 038-03 ES | 039-88 ES | 049-06 ER | 000-122 ER | 000-146 ER | 600-20 ER | 600-26 ER |
| 038-07 ES | 039-89 ES | 050-01 ER | 000-123 ER | 000-147 ER | 600-21 ER | 600-27 ER |
| 038-08 ES | 039-90 ES | 050-02 ER | 000-141 ER | | | |
| | | | | | **Total** | **46** |

## OU VI – EDB Plume

| | | | | | | |
|---|---|---|---|---|---|---|
| 058-02 ER | 099-10 ER | 100-14 ER | 000-175 ER | 000-179 ER | 000-209 ER | 800-24 ER |
| 089-13 ER | 099-11 ER | 000-110 ER | 000-176 ER | 000-180 ER | 000-283 ER | 800-25 ER |
| 089-14 ER | 100-12 ER | 000-173 ER | 000-177 ER | 000-181 ER | 000-284 ER | 800-54 ER |
| 099-06 ER | 100-13 ER | 000-174 ER | 000-178 ER | 000-201 ER | 000-285 ER | |
| | | | | | **Total** | **27** |

## North Boundary - Background Wells

| | | | | | | |
|---|---|---|---|---|---|---|
| 000-118 ER | 000-120 ER | 017-03 ER | 018-01 ER | 018-04 ER | 034-02 ER | 063-09 ER |
| 000-119 ER | 017-01 ER | 017-04 ER | 018-02 ER | 018-05 ER | 034-03 ER | |
| | | | | | **Total** | **13** |

APPENDIX F

# *Quality Control Tables*

This appendix presents the tables for Chapter 9, Quality Assurance. The tables show performance evaluation (PE) results for the ASL as well as three BNL contractor laboratories (H2M, GEL, and STL) that participated in national and/or state PE testing programs during 2000. Section 9.7 of the SER describes the data shown in the 8 tables. The detailed data contained in the tables were also used to determine the overall PE score of each participating laboratory, for both radiological and nonradiological programs. The combined overall PE test scores (i.e., acceptable, warning, and unacceptable) are summarized as bar graphs in Figures 9-2 and 9-3 of the text for each laboratory by PE testing program.

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Table F-8. Summary of Water Supply and Water Pollution Studies Environmental Resources Associates (ERA). ..... 19


**Table F-1. Groundwater Duplicate Data* (CY 2000).**

| Parameter | Number of Duplicates | Acceptable[a] | Percent Acceptable |
|---|---|---|---|
| Gross Alpha | 7 | 7 | 100 |
| Gross Beta | 17 | 15 | 90 |
| Tritium | 26 | 25 | 96 |
| Strontium-90 | 14 | 14 | 100 |
| Gamma Spectroscopy | 10 | 10 | 100 |
| Alpha Spectroscopy | 4 | 3 | 75 |
| Volatile Organic Compounds | 111 | 111 | 100 |
| Ethylene Dibromide | 127 | 127 | 100 |
| Semivolatile Organic Compo | 6 | 6 | 100 |
| Pesticides | 3 | 3 | 100 |
| Metals | 17 | 17 | 100 |
| Classical Chemistry | 17 | 17 | 100 |

Notes:
[a] Acceptability requirements are based on USEPA Region II duplicate guiedlines.
* Field duplicates were only ingested into the database beginning in April 2000, therefore these totals do not include the samples collected during the first quarter of 2000.

**Table F-2. Quality Assessment Program #52, #53: 2000 Radiological Results Environmental Measurements Laboratory (CY 2000).**

| Matrix | Units | Isotope | Date | BNL Results [a] | GEL Results |
|---|---|---|---|---|---|
| Air Filter | Bq/Filter | Alpha | Mar-00 | Warning | Acceptable |
| | | | Sep-00 | Acceptable | Acceptable |
| | | Beta | Mar-00 | Not acceptable | Acceptable |
| | | | Sep-00 | Warning | Acceptable |
| | | Co-57 | Mar-00 | Acceptable | Acceptable |
| | | | Sep-00 | Acceptable | Acceptable |
| | | Co-60 | Mar-00 | Warning | Acceptable |
| | | | Sep-00 | Warning | Acceptable |
| | | Cs-137 | Mar-00 | Acceptable | Acceptable |
| | | | Sep-00 | Acceptable | Acceptable |
| | | Mn-54 | Mar-00 | NT | Acceptable |
| | | | Sep-00 | Acceptable | Acceptable |
| | | Ru-106 | Mar-00 | NT | Not acceptable |
| | | | Sep-00 | NT | Acceptable |
| | | Sr-90 | Mar-00 | NT | Warning |
| | | | Sep-00 | NT | Acceptable |
| | | U-234 | Mar-00 | NT | Warning |
| | | | Sep-00 | NT | Acceptable |
| | | U-238 | Mar-00 | NT | Acceptable |
| | | | Sep-00 | NT | Warning |
| | | ug U | Mar-00 | NT | Warning |
| | | | Sep-00 | NT | Acceptable |
| | | Pu-238 | Mar-00 | NT | Acceptable |
| | | | Sep-00 | NT | Acceptable |
| | | Pu-239 | Mar-00 | NT | Warning |
| | | | Sep-00 | NT | Acceptable |
| | | Am-241 | Mar-00 | NT | Acceptable |
| | | | Sep-00 | NT | Acceptable |
| Vegetation | Bq/kg | Co-60 | Mar-00 | Acceptable | Warning |
| | | | Sep-00 | Warning | Acceptable |
| | | Cs-137 | Mar-00 | Acceptable | Warning |
| | | | Sep-00 | Acceptable | Acceptable |
| | | K-40 | Mar-00 | Acceptable | Warning |
| | | | Sep-00 | Warning | Acceptable |
| | | Sr-90 | Mar-00 | NT | Not acceptable |
| | | | Sep-00 | NT | Warning |
| | | Pu-239 | Mar-00 | NT | Acceptable |
| | | | Sep-00 | NT | Acceptable |
| Vegetation | Bq/kg | Am-241 | Mar-00 | NT | Acceptable |
| | | | Sep-00 | NT | Acceptable |
| | Cm-244 | | Mar-00 | NT | Warning |
| | | | Sep-00 | NT | Acceptable |
| Water | Bq/L | Alpha | Mar-00 | Acceptable * | Acceptable |
| | | | Sep-00 | Not acceptable | Acceptable |
| | | Beta | Mar-00 | Acceptable * | Warning |
| | | | Sep-00 | Warning | Acceptable |
| | | Co-60 | Mar-00 | Acceptable | Acceptable |
| | | | Sep-00 | Acceptable | Acceptable |
| | | Cs-137 | Mar-00 | Acceptable | Acceptable |
| | | | Sep-00 | Acceptable | Acceptable |
| | | H-3 | Mar-00 | Not acceptable | Acceptable |

*(continued)*

**Table F-2. Quality Assessment Program #52, #53: 2000 Radiological Results Environmental Measurements Laboratory (CY 2000)** *(concluded)*.

| Matrix | Units | Isotope | Date | BNL Results [a] | GEL Results |
|---|---|---|---|---|---|
| | | | Sep-00 | Acceptable | Acceptable |
| | | Sr-90 | Mar-00 | Not acceptable | Acceptable |
| | | | Sep-00 | Acceptable | Warning |
| | | Fe-55 | Mar-00 | NT | Acceptable |
| | | U-234 | Mar-00 | NT | Acceptable |
| | | | Sep-00 | NT | Warning |
| | | U-238 | Mar-00 | NT | Acceptable |
| | | | Sep-00 | NT | Warning |
| | | ug U | Mar-00 | NT | Acceptable |
| | | | Sep-00 | NT | Warning |
| | | Pu-238 | Mar-00 | NT | Not Acceptable |
| | | Sep-100 | | NT | Acceptable |
| | | Pu-239 | Mar-00 | NT | Warning |
| | | Sep-100 | | NT | Acceptable |
| | | Am-241 | Mar-00 | NT | Warning |
| | | Sep-100 | | NT | Acceptable |
| | | Ni-63 | Mar-00 | NT | Acceptable |
| Soil | Bq/kg | Ac-228 | Mar-00 | Warning | Acceptable |
| | | | Sep-00 | Warning | Acceptable |
| | | Bi-212 | Mar-00 | Acceptable | Acceptable |
| | | | Sep-00 | Warning | Acceptable |
| | | Bi-214 | Mar-00 | Acceptable | Acceptable |
| | | | Sep-00 | Acceptable | Acceptable |
| | | Cs-137 | Mar-00 | Acceptable | Acceptable |
| | | | Sep-00 | Acceptable | Acceptable |
| Soil | Bq/kg | K-40 | Mar-00 | Warning | Acceptable |
| | | | Sep-00 | Warning | Acceptable |
| | | Pb-212 | Mar-00 | Acceptable | Acceptable |
| | | | Sep-00 | Acceptable | Acceptable |
| | | Pb-214 | Mar-00 | Acceptable | Acceptable |
| | | | Sep-00 | Acceptable | Acceptable |
| | | Sr-90 | Mar-00 | NT | Warning |
| | | | Sep-00 | NT | Acceptable |
| | | U-234 | Mar-00 | NT | Acceptable |
| | | | Sep-00 | NT | Warning |
| | | U-238 | Mar-00 | NT | Acceptable |
| | | | Sep-00 | NT | Warning |
| | | ug U | Mar-00 | NT | Acceptable |
| | | | Sep-00 | NT | Acceptable |
| | | Pu-239 | Mar-00 | NT | Warning |
| | | | Sep-00 | NT | Acceptable |
| | | Am-241 | Mar-00 | NT | Acceptable |
| | | | Sep-00 | NT | Acceptable |
| | | Th-234 | Mar-00 | NT | Acceptable |
| | | | Sep-00 | NT | Warning |

Notes:
(*) Acceptable after correction for dilution
([a]) Results column provides EML evaluation of analytical performance which is based on control limits established from percentiles of historic data distributions. No comment indicates performance within acceptable limits. Refer to Calandar Year 2000 ASL Quality Assurance Report for detailed data.
NT = Not Tested

**Table F-3. Radiological Potable Water Radiochemistry Proficiency Test Results Environmental Laboratory Approval Program (ELAP) (CY 2000).**

| Radionuclide | BNL Result | GEL Result |
|---|---|---|
| Gross Alpha - Apr 2000 | Acceptable | Acceptable |
| Gross Alpha - Nov 2000 | Acceptable | NT |
| Gross Beta - Apr 2000 | Unacceptable | Acceptable |
| Gross Beta - Nov 2000 | Acceptable | NT |
| Tritium | NT | Acceptable |
| Uranium | NT | Acceptable |
| Radium-226 | NT | Unacceptable |
| Cobalt-60 | NT | Warning |
| Cesium-134 | NT | Acceptable |
| Cesium-137 | NT | Warning |
| Strontium-89 | NT | Acceptable |
| Strontium-90 | NT | Acceptable |

Notes:
Results for all labs are summarized as acceptable, check for error or unacceptable.
Refer to Calandar Year 2000 ASL Quality Assurance Report for detailed data
NT = Not Tested

**Table F-4. InterLab RadCheM Proficiency Test Results Environmental Resource Associates (ERA) (CY 2000).**

| Analyte | Date | BNL Result[a] | GEL Result |
|---|---|---|---|
| Alpha | Feb-00 | Acceptable | Acceptable |
| | Apr-00 | Acceptable | Acceptable |
| | Jul-00 | Acceptable | Acceptable |
| | Sep-00 | Acceptable | Acceptable |
| | Dec-00 | Acceptable | Acceptable |
| | Dec-00 | Acceptable | Acceptable |
| Beta | Feb-00 | Acceptable | Acceptable |
| | Apr-00 | Acceptable | Acceptable |
| | Jul-00 | Acceptable | Acceptable |
| | Sep-00 | Acceptable | Acceptable |
| | Dec-00 | Acceptable | Acceptable |
| | Dec-00 | Acceptable | Acceptable |
| Ba-133 | Aug-00 | Acceptable | NT |
| | Dec-00 | Acceptable | NT |
| Co-60 | Jul-00 | Acceptable | Warning |
| | Aug-00 | Acceptable | NT |
| | Dec-00 | Acceptable | NT |
| | Dec-00 | Acceptable | NT |
| Cs-134 | Jul-00 | Acceptable | Acceptable |
| | Aug-00 | Acceptable | NT |
| | Dec-00 | Acceptable | NT |
| | Dec-00 | Acceptable | NT |
| Cs-137 | Jul-00 | Warning | Warning |
| | Aug-00 | Acceptable | NT |
| | Dec-00 | Warning | NT |
| | Dec-00 | Acceptable | NT |
| Zn-65 | Aug-00 | Warning | NT |
| | Dec-00 | Acceptable | NT |
| H-3 | Mar-00 | Not acceptable | Acceptable |
| | Sep-00 | Not acceptable | NT |
| Ra-226 | Feb-00 | NT | Unacceptable |
| Ra-228 | Feb-00 | NT | Acceptable |
| I-131 | Aug-00 | NT | Warning |

Notes:
Refer to Calandar Year 2000 ASL Quality Assurance Report for detailed data
[a]Result column provides ERA evaluation of analytical performance which is based on 95 and 99% confidence interval about the target value.
NT = Not Tested

**Table F-5. Summary of Contract Laboratory Proficiency Test Results for Non-Potable Water New York State Department of Health ELAP-NPW (CY 2000).**

| | | January 2000 | | | | | July 2000 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **STL-CT** | **STL-MO** | **H2M** | **BNL** | **GEL** | **STL-CT** | **STL- MO** | **H2M** |
| Non-potable Water | | | | | | | | | | | |
| Demand | | | | | | | | | | | |
| | Total Organic Carbon | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| Residue | | | | | | | | | | | |
| | Total Dissolved Solids | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| | Total Suspended Solids | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Unsatisfactory | Satisfactory |
| | Total Solids | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| Hydrogen Ion | | | | | | | | | | | |
| | pH | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| Organic Nutrients | | | | | | | | | | | |
| | Total Kjedahl Nitrogen | NT | Satisfactory | Unsatisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Unsatisfactory | Unsatisfactory |
| | Phosphorus | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Unsatisfactory | Satisfactory |
| Alkalinity | | | | | | | | | | | |
| | Alkalinity | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Unsatisfactory | Satisfactory |
| Inorganic Nutrients | | | | | | | | | | | |
| | Ammonia | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| | Nitrate | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| | Orthophosphate | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| Minerals | | | | | | | | | | | |
| | Chloride | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory | Satisfactory | Unsatisfactory |
| | Sulfate | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Unsatisfactory |
| Phenols | | | | | | | | | | | |
| | Phenols | NT | Unsatisfactory | Unsatisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| Oil and Grease | | | | | | | | | | | |
| | Oil and Grease | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| CLP | | | | | | | | | | | |
| | Cyanide | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Mercury | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Aluminum | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Barium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Berylium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Calcium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Cadmium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Cobalt | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Chromium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Copper | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Iron | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Potassium | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Magnesium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Manganese | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Sodium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Nickel | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Lead | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Selenium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Vanadium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Zinc | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| CLP Metals IV | | | | | | | | | | | |
| | Silver | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | NT |
| | Arsenic | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | NT |

*(continued on next page)*

**Table F-5. Summary of Contract Laboratory Proficiency Test Results for Non-Potable Water New York State Department of Health ELAP-NPW (CY 2000)** *(continued)*.

| | | January 2000 | | | | | July 2000 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **STL-CT** | **STL-MO** | **H2M** | **BNL** | **GEL** | **STL-CT** | **STL- MO** | **H2M** |
| | Antimony | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | NT |
| | Thallium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | NT |
| Mercury | | | | | | | | | | | |
| | Mercury | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| Metals I and II | | | | | | | | | | | |
| | Silver | Satisfactory | NT | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Aluminum | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Arsenic | Satisfactory | NT | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Barium | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Beryllium | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Calcium | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Cobalt | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Cadmium | Satisfactory | NT | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Chromium | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Copper | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Iron | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Potassium | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Magnesium | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Manganese | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Sodium | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Nickel | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Lead | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Selenium | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Antimony | Satisfactory | NT | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Thallium | Satisfactory | NT | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Vanadium | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Zinc | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| Metals III | | | | | | | | | | | |
| | Molybdenum | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| Metals IV | | | | | | | | | | | |
| | Silver | NT | Satisfactory | NT | NT | NT | NT | NT | NT | NT | NT |
| | Arsenic | NT | Satisfactory | NT | NT | NT | NT | NT | NT | NT | NT |
| | Antimony | NT | Satisfactory | NT | NT | NT | NT | NT | NT | NT | NT |
| | Thallium | NT | Satisfactory | NT | NT | NT | NT | NT | NT | NT | NT |
| Organophosphate Pesticides | | | | | | | | | | | |
| | Parathion methyl | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| Cyanide | | | | | | | | | | | |
| | Cyanide, total | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| CLP Volatiles | | | | | | | | | | | |
| | 1,1,1-Trichloroethane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 1,1,2,2-Tetrachloroethane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 1,1,2-Trichloroethane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 1,1-Dichloroethane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 1,1-Dichloroethene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 1,2-Dichloroethane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 1,2-Dichloroethene (total) | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 1,2-Dichloropropane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Acetone | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |

*(continued on next page)*

**Table F-5. Summary of Contract Laboratory Proficiency Test Results for Non-Potable Water New York State Department of Health ELAP-NPW (CY 2000)** *(continued)*.

| | | January 2000 | | | | | July 2000 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **STL-CT** | **STL-MO** | **H2M** | **BNL** | **GEL** | **STL-CT** | **STL- MO** | **H2M** |
| | Benzene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Bromodichloromethane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Bromoform | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | cis-1,3-Dichloropropene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Carbon tetrachloride | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Bromomethane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Chloromethane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Unsatisfactory |
| | Chlorobenzene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Dibromochloromethane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Chloroethane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Unsatisfactory | NT | Satisfactory |
| | Chloroform | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Carbon disulfide | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Ethyl benzene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2-Hexanone | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Methyl chloride | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Methylethyl ketone | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Methyl-2-pentanone | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Styrene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | trans-1,3-Dichloropropene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Tetrachloroethene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Toluene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Unsatisfactory |
| | Trichloroethene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Xylenes (total) | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Vinyl chloride | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| Purgable Aromatics | | | | | | | | | | | |
| | 1,3-Dichlorobenzene | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Benzene | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Chlorobenzene | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Ethyl benzene | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Toluene | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | total Xylenes | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| Purgable Halocarbons | | | | | | | | | | | |
| | 1,1,1-Trichloroethane | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | 1,1,2,2-Tetrachloroethane | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | 1,1-Dichloroethene | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | 1,2-Dichloroethane | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Carbon tetrachloride | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Bromomethane | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Bromodichloromethane | Satisfactory | NT | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Dibromomethane | NT | Satisfactory | NT | NT | NT | Satisfactory | | | | |
| | Chloroethane | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Chloroform | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Methylene chloride | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | Trichloroethene | NT | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| Nitrosamines | | | | | | | | | | | |
| | N-Nitrosodimethylamine | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | NT | Satisfactory | NT |
| | N-Nitrosodiphenylamine | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | N-Nitrosodi-n-propylamine | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |

*(continued on next page)*

**Table F-5. Summary of Contract Laboratory Proficiency Test Results for Non-Potable Water New York State Department of Health ELAP-NPW (CY 2000)** *(continued)*.

| | | January 2000 | | | | | July 2000 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **STL-CT** | **STL-MO** | **H2M** | **BNL** | **GEL** | **STL-CT** | **STL- MO** | **H2M** |
| Benzidines | | | | | | | | | | | |
| | 3,3'-Dichlorobenzidine | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Benzidene | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | NT |
| Chlorinated Hydrocarbons | | | | | | | | | | | |
| | 1,2,4-Trichlorobenzene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2-Chloronaphthalene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Hexachlorobenzene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Hexachlorobutadiene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Hexachloroethane | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Hexachlorocyclopentadiene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| CLP Semivolatiles | | | | | | | | | | | |
| | 1,2,4-Trichlorobenzene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 1,2-Dichlorobenzene | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 1,3-Dichlorobenzene | NT | NT | Satisfactory | NT | Unsatisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 1,4-Dichlorobenzene | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2,4,5-Trichlorophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2,4,6-Trichlorophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2,4-Dichlorophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2,4-Dimethylphenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2,4-Dinitrophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Unsatisfactory |
| | 2,4-Dinitrotoluene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2,6-Dinitrotoluene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2-Chloronaphthalene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2-Chlorophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Chlorophenylphenyl ether | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2-Methyl,4,6-dinitrophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2-Methylnaphthalene | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2-Methylphenol | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2-Nitroanaline | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2-Nitrophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 3,3-Dichlorobenzidine | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Unsatisfactory |
| | 3-Nitroanaline | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Bromophenylphenyl ether | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Chloro-3-methylphenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Chloroanaline | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Methylphenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Nitroaniline | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Nitrophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Acenaphthene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Anthracene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Acenaphthylene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | bis(2-Chloroethyl)ether | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | bis(2-Chloroethoxy)ether | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | bis(2-Chloroethoxy)methane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | bis(2-Chloroisopropyl)ether | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | bis(2-Ethylhexyl)phthalate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Benzo(a)anthracene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Benzo(a)pyrene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |

*(continued on next page)*

**Table F-5. Summary of Contract Laboratory Proficiency Test Results for Non-Potable Water New York State Department of Health ELAP-NPW (CY 2000)** *(continued)*.

| | | January 2000 | | | | | July 2000 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **STL-CT** | **STL-MO** | **H2M** | **BNL** | **GEL** | **STL-CT** | **STL- MO** | **H2M** |
| | Benzo(b)fluoranthene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Benzo(ghi)perylene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Benzo(k)fluoranthene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Benzyl butyl phthalate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Carbazole | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Chrysene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Dibenzo(a,h)anthracene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Di-n-butyl phthalate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Dibenzofuran | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Diethyl phthalate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Dimethyl phthalate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Di-n-octyl phthalate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Flouranthene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Flourene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Hexachlorobenzene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Hexachlorobutadiene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Hexachloroethane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Hexachlorocyclopentadiene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Indeno(1,2,3-cd)pyrene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Isophorone | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Unsatisfactory |
| | Naphthalene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Nitrobenzene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | N-Nitrosodiphenylamine | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | N-Nitrosodi-n-propylamine | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Phenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Pentachlorophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Phenanthrene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Pyrene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| Phthalate Esters | | | | | | | | | | | |
| | bis(2-Ethylhexyl)phthalate | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Benzyl butyl phthalate | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Di-n-butyl phthalate | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Diethyl phthalate | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Dimethyl phthalate | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Di-n-octyl phthalate | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Haloethers | | | | | | | | | | | |
| | 4-Chlorophenylphenyl ether | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 4-Bromophenylphenyl ether | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Bis(2-chloroethyl)ether | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Bis(2-chloroethoxy)methane | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Bis(2-chloroisopropyl) ether | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Nitroaromatics and Isophorone | | | | | | | | | | | |
| | 2,4-Dinitrotoluene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2,6-Dinitrotoluene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Isophorone | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Nitrobenzene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Polynuclear Aromatic Hydrocarbons | | | | | | | | | | | |
| | Acenaphthene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |

*(continued on next page)*

**Table F-5. Summary of Contract Laboratory Proficiency Test Results for Non-Potable Water New York State Department of Health ELAP-NPW (CY 2000)** *(continued)*.

| | | January 2000 | | | | | July 2000 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **STL-CT** | **STL-MO** | **H2M** | **BNL** | **GEL** | **STL-CT** | **STL- MO** | **H2M** |
| | Anthracene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Benzo(a)anthracene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Benzo(a)pyrene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Benzo(b)fluoranthene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Fluoranthene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Indeno(1,2,3-cd)pyrene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Pyrene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Priority Pollutant Phenols | | | | | | | | | | | |
| | 2,4,5-Trichlorophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2,4,6-Trichlorophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2,4-Dichlorophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2,4-Dimethylphenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2,4-Dinitrophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2-Chlorophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2-Methyl-4,6-dinitrophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2-Nitrophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 4-Chloro-3-methyl phenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 4-Nitrophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Phenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Pentachlorophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Chlordane | | | | | | | | | | | |
| | Chlordane | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | NT | Satisfactory |
| CLP Polychlorinated Biphenyls | | | | | | | | | | | |
| | PCB-1016 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | PCB-1221 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | PCB-1232 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | PCB-1242 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | PCB-1248 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | PCB-1254 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | PCB-1260 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| Polychlorinated Biphenyls | | | | | | | | | | | |
| | PCB 1232 | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Unsatisfactory | NT | Satisfactory | NT |
| | PCB 1260 | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Unsatisfactory | NT |
| CLP Pesticides | | | | | | | | | | | |
| | 4,4-DDD | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4,4-DDE | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4,4-DDT | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | alpha-BHC | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | alpha-Chlordane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Aldrin | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | beta-BHC | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | delta-BHC | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Dieldrin | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Endrin aldehyde | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Endrin ketone | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Endrin | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Endosulfan I | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Endosulfan II | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |

*(continued on next page)*

**Table F-5. Summary of Contract Laboratory Proficiency Test Results for Non-Potable Water New York State Department of Health ELAP-NPW (CY 2000)** *(continued)*.

| | | January 2000 | | | | | July 2000 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **STL-CT** | **STL-MO** | **H2M** | **BNL** | **GEL** | **STL-CT** | **STL- MO** | **H2M** |
| | Endosulfan sulfate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | gamma-Chlordane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Heptachlor | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Heptachlor epoxide | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Lindane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Methoxychlor | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Toxaphene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| Chlorinated Hydrocarbon Pesticides | | | | | | | | | | | |
| | 4,4-DDE | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 4,4-DDT | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Aldrin | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Beta-BHC | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | delta-BHC | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Endrin | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Endosulfan II | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Heptachlor | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Methoxychlor | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Chlorophenoxy Acid Pesticides (Herbicides) | | | | | | | | | | | |
| | 2,4,5-T | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| | 2,4-D | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| | 2,4,5-TP (Silvex) | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| Solid and Hazardous Waste | | | | | | | | | | | |
| CLP Metals | | | | | | | | | | | |
| | Silver | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Aluminum | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Arsenic | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Barium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Beryllium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Calcium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Cadmium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Cyanide | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Unsatisfactory |
| | Cobalt | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Copper | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Iron | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Mercury | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Potassium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Magnesium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Manganese | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Sodium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Nickel | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Lead | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Antimony | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Selenium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Thallium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Vanadium | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Zinc | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |

*(continued on next page)*

**Table F-5. Summary of Contract Laboratory Proficiency Test Results for Non-Potable Water New York State Department of Health ELAP-NPW (CY 2000)** *(continued)*.

| | | January 2000 | | | | | July 2000 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **STL-CT** | **STL-MO** | **H2M** | **BNL** | **GEL** | **STL-CT** | **STL- MO** | **H2M** |
| Metals | | | | | | | | | | | |
| | Silver | Satisfactory | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Arsenic | Satisfactory | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Barium | Satisfactory | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Cadmium | Satisfactory | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Chromium | Satisfactory | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Nickel | Satisfactory | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Lead | Satisfactory | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Antimony | Satisfactory | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Selenium | Satisfactory | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Chlorinated Hydrocarbons | | | | | | | | | | | |
| | 1,2,4-Trichlorobenzene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2-Chloronaphthalene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Hexachlorobenzene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Hexachlorobutadiene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Hexachloroethane | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Hexachlorocyclopentadiene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Phthalate Esters | | | | | | | | | | | |
| | Bis(2-ethylhexyl)phthalate | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Benzyl butyl phthalate | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Di-n-butyl phthalate | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Diethylphthalate | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Dimethyl phthalate | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Di-n-octyl phthalate | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Haloethers | | | | | | | | | | | |
| | Bis(2-chloroisopropyul)ether | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Bis(2-chloroethoxy)methane | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Nitroaromatics and Isophorone | | | | | | | | | | | |
| | 2,4-Dinitrotoluene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2,6-Dinitrotoluene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Isophorone | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Nitrobenzene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Polynuclear Aromatic Hydrocarbons | | | | | | | | | | | |
| | Acenaphthylene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Benzo(b)fluoranthene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Benzo(ghi)perylene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Chrysene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Dibenzo(a,h)anthracene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Fluorene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Naphthalene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Phenanthrene | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Priority Pollutant Phenols | | | | | | | | | | | |
| | 2,4,6-Trichlorophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2,4-Dichlorophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2,4-Dimethylphenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2,4-Dinitrophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2-Chlorophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 2-Methyl-4,6-dinitrophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |

*(continued on next page)*

**Table F-5. Summary of Contract Laboratory Proficiency Test Results for Non-Potable Water New York State Department of Health ELAP-NPW (CY 2000)** *(continued)*.

| | | January 2000 | | | | | July 2000 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **STL-CT** | **STL-MO** | **H2M** | **BNL** | **GEL** | **STL-CT** | **STL- MO** | **H2M** |
| | 2-nitrophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 4-Chloro-3-methylphenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | 4-Nitrophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Phenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Pentachlorophenol | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Polychlorinated Biphenyls | | | | | | | | | | | |
| | PCB-1016 | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | PCB-1221 | NT | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | PCB-1232 | Satisfactory | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Unsatisfactory | NT |
| | PCB-1242 | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | PCB-1248 | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | PCB-1254 | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT |
| | PCB-1260 | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | Satisfactory | NT | Unsatisfactory | NT |
| Chlorinated Hydrocarbon Pesticides | | | | | | | | | | | |
| | 4,4-DDD | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | alpha-BHC | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Dieldrin | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Endrin aldehyde | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Endosulfan I | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Endosulfan sulfate | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Heptachlor epoxide | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| | Lindane | NT | Satisfactory | NT | NT | NT | NT | Satisfactory | NT | Satisfactory | NT |
| Chlorophenoxy Acid Pesticides | | | | | | | | | | | |
| | 2,4,5-T | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory |
| | 2,4-D | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory |
| | 2,4,5-TP(Silvex) | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| | Chlordane | NT | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| Organophosphate Pesticides | | | | | | | | | | | |
| | Parathion methyl | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Unsatisfactory | NT | Satisfactory |
| CLP Semivolatiles | | | | | | | | | | | |
| | 1,2,4-Trichlorobenzene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 1,2-Dichlorobenzene | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 1,3-Dichlorobenzene | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 1,4-Dichlorobenzene | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2,4,5-Trichlorophenol | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Unsatisfactory |
| | 2,4,6-Trichlorophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2,4-Dichlorophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2,4-Dimethylphenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2,4-Dinitrophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2,4-Dinitrotoluene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2,6-Dinitrotoluene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2-Chloronaphthalene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2-Chlorophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Chlorophenylphenyl ether | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2-Methyl-4,6-dinitrophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Unsatisfactory |
| | 2-Methylnaphthalene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2-Methylphenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 2-Nitroanaline | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Unsatisfactory |
| | 2-Nitrophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |

*(continued on next page)*

**Table F-5. Summary of Contract Laboratory Proficiency Test Results for Non-Potable Water New York State Department of Health ELAP-NPW (CY 2000)** *(continued)*.

| | | January 2000 | | | | | July 2000 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **STL-CT** | **STL-MO** | **H2M** | **BNL** | **GEL** | **STL-CT** | **STL- MO** | **H2M** |
| | 3,3-Dichlorobenzidine | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 3-Nitroanaline | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Bromophenylphenyl ether | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Chloro-3-methylphenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Chloroanaline | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Methylphenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Nitroaniline | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4-Nitrophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Acenaphthene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Anthracene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Acenaphthylene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Unsatisfactory | NT | Satisfactory |
| | bis(2-Chloroethyl)ether | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Unsatisfactory |
| | bis(2-Chloroethoxy)ether | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | bis(2-Chloroethoxy)methane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | bis(2-Chloroisopropyl)ether | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | bis(2-Ethylhexyl)phthalate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Benzo(a)anthracene | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Benzo(a)pyrene | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Benzo(b)fluoranthene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Benzo(ghi)perylene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Benzo(k)fluoranthene | NT | NT | Unsatisfactory | NT | Unsatisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Benzyl butyl phthalate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Carbazole | NT | NT | Unsatisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Chrysene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Dibenzo(a,h)anthracene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Di-n-butyl phthalate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Dibenzofuran | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Diethyl phthalate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Dimethyl phthalate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Di-n-octyl phthalate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Flouranthene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Flourene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Hexachlorobenzene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Hexachlorobutadiene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Hexachloroethane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Hexachlorocyclopentadiene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Indeno(1,2,3-cd)pyrene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Isophorone | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Naphthalene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Unsatisfactory |
| | Nitrobenzene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | N-Nitrosodiphenylamine | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | N-Nitrosodi-n-propylamine | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Phenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Pentachlorophenol | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Phenanthrene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Pyrene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| CLP Polychlorinated Biphenyls | | | | | | | | | | | |
| | PCB-1016 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | PCB-1221 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |

*(continued on next page)*

**Table F-5. Summary of Contract Laboratory Proficiency Test Results for Non-Potable Water New York State Department of Health ELAP-NPW (CY 2000)** *(concluded)*.

| | | January 2000 | | | | | July 2000 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **STL-CT** | **STL-MO** | **H2M** | **BNL** | **GEL** | **STL-CT** | **STL- MO** | **H2M** |
| | PCB-1232 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | PCB-1242 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | PCB-1248 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | PCB-1254 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | PCB-1260 | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| CLP Pesticides | | | | | | | | | | | |
| | 4,4-DDD | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4,4-DDE | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | 4,4-DDT | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | alpha-BHC | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | alpha-Chlordane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Aldrin | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | beta-BHC | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | delta-BHC | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Dieldrin | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Endrin aldehyde | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Endrin ketone | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Endrin | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Endosulfan I | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Endosulfan II | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Endosulfan sulfate | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | gamma-Chlordane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Heptachlor | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Heptachlor epoxide | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Lindane | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Methoxychlor | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |
| | Toxaphene | NT | NT | Satisfactory | NT | Satisfactory | NT | NT | Satisfactory | NT | Satisfactory |

Notes:
Results for all off-site contractor labs are summarized as acceptable, check for error or unacceptable.
NT = Not Tested

**Table F-6. ASL Solid & Hazardous Waste Chemistry Proficiency Test #223 Results Environmental Laboratory Approval Program (ELAP) (CY 2000).**

| Analyte | Date | Result [a] |
|---|---|---|
| Antimony | Jan-00 | Acceptable |
| Arsenic | Jan-00 | Acceptable |
| Barium | Jan-00 | Acceptable |
| Cadium | Jan-00 | Acceptable |
| Chromium | Jan-00 | Acceptable |
| Lead | Jan-00 | Acceptable |
| Nickel | Jan-00 | Acceptable |
| PCB-1016 | Jan-00 | Acceptable |
| | Jul-00 | Acceptable |
| PCB-1232 | Jan-00 | Acceptable |
| | Jul-00 | Acceptable |
| PCB-1221 | Jul-00 | Acceptable |
| PCB-1222 | Jan-00 | Acceptable |
| PCB-1242 | Jan-00 | Acceptable |
| | Jul-00 | Acceptable |
| PCB-1248 | Jan-00 | Acceptable |
| | Jul-00 | Acceptable |
| PCB-1260 | Jan-00 | Acceptable |
| | Jul-00 | Acceptable |
| PCB-1254 | Jan-00 | Acceptable |
| | Jul-00 | Acceptable |
| Selenium | Jan-00 | Acceptable |
| Silver | Jan-00 | Acceptable |

Notes:
Refer to Calandar Year 2000 ASL Quality Assurance Report for detailed data
[a] Result column provides ELAP evaluation of analytical performance which is based on 95 and 99% confidence interval about the target value.

**Table F-7. Summary of Contract Laboratory Proficiency Test Results for Potable Water New York State Department of Health ELAP (CY 2000).**

| | | April 2000 | | | | May 2000 | October 2000 | | |
|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **H2M** | **STL- MO** | **H2M** | **BNL** | **H2M** | **STL- MO** |
| Alkalinity | | | | | | | | | |
| | Alkalinity | NT | Satisfactory | Satisfactory | Satisfactory | NT | NT | Satisfactory | Satisfactory |
| Minerals | | | | | | | | | |
| | Chloride | Satisfactory | Satisfactory | Unsatisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Nitrate | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Total Dissolved Solids | NT | Satisfactory | Satisfactory | Satisfactory | NT | NT | Satisfactory | Unsatisfactory |
| | Sulfate | Satisfactory | Satisfactory | Unsatisfactory | Satisfactory | NT | Satisfactory | Unsatisfactory | Satisfactory |
| Hydrogen Ion | pH | NT | Satisfactory | Satisfactory | Satisfactory | NT | NT | Satisfactory | Satisfactory |
| Cyanide | | | | | | | | | |
| | Cyanide | NT | Satisfactory | Satisfactory | Satisfactory | NT | NT | Satisfactory | Satisfactory |
| Metals | | | | | | | | | |
| | Silver | Satisfactory | Satisfactory | Satisfactory | Unsatisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Arsenic | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Barium | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Beryllium | Unsatisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Cadmium | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Chromium | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Copper | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Unsatisfactory | Satisfactory | Satisfactory |
| | Iron | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Mercury | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Unsatisfactory |
| | Manganese | Satisfactory | Satisfactory | Satisfactory | Unsatisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Sodium | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Nickel | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Lead | Satisfactory | Satisfactory | Satisfactory | Unsatisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Antimony | Satisfactory | Satisfactory | Satisfactory | Unsatisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Selenium | Satisfactory | Satisfactory | Satisfactory | Unsatisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Thallium | Satisfactory | Satisfactory | Satisfactory | Unsatisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Zinc | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Unsatisfactory | Satisfactory | Satisfactory |
| Trihalomethanes | | | | | | | | | |
| | Bromodichloromethane | NT | Satisfactory | Satisfactory | Satisfactory | NT | NT | Satisfactory | Satisfactory |
| | Bromoform | NT | Satisfactory | Satisfactory | Satisfactory | NT | NT | Unsatisfactory | Satisfactory |
| | Dibromochloromethane | NT | Satisfactory | Satisfactory | Satisfactory | NT | NT | Satisfactory | Satisfactory |
| | Chloroform | NT | Satisfactory | Satisfactory | Satisfactory | NT | NT | Satisfactory | Satisfactory |
| Gross Alpha and Gross Beta | | | | | | | | | |
| | Gross Alpha | Unsatisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | NT | Satisfactory |
| | Gross Beta | Satisfactory | Satisfactory | NT | Satisfactory | NT | Satisfactory | NT | Satisfactory |
| Radium | | | | | | | | | |
| | Radium-226 | NT | Unsatisfactory | NT | Unsatisfactory | NT | NT | NT | Satisfactory |

*(continued on next page)*

**Table F-7. Summary of Contract Laboratory Proficiency Test Results for Potable Water New York State Department of Health ELAP (CY 2000)** *(continued)*.

| | | April 2000 | | | | May 2000 | October 2000 | | |
|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **H2M** | **STL- MO** | **H2M** | **BNL** | **H2M** | **STL- MO** |
| Volatile Halocarbons | | | | | | | | | |
| | 1,1,1,2-Tetrachloroethane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,1,1-Trichloroethane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,1,2,2-Tetrachloroethane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Unsatisfactory | Satisfactory | Satisfactory |
| | 1,1,2-Trichloroethane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,1-Dichloroethane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,1-Dichloroethene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,1-Dichloropropane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,2,3-Trichloropropane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,2-Dichloroethane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | cis-1,2-Dichloroethylene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,2-Dichloropropane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,3-Dichloropropane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 2,2-Dichloropropane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Bromochloromethane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | cis-1,3-Dichloropropylene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Carbon tetrachloride | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Unsatisfactory |
| | Bromomethane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Chloromethane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Trichlorofluoromethane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Chloroethane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Dibromomethane | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Dichlorodifluoromethane | NT | NT | NT | NT | NT | Satisfactory | Satisfactory | Unsatisfactory |
| | Methylene chloride | Satisfactory | Satisfactory | Satisfactory | Unsatisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | trans-1,2-Dichloroethene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | trans-1,3-Dichloropropylene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Tetrachloroethylene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Trichloroethylene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Vinyl chloride | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Unsatisfactory |
| Volatile Aromatics | | | | | | | | | |
| | 1,2,3-Trichlorobenzene | Unsatisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,2,4-Trichlorobenzene | Unsatisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Unsatisfactory | Satisfactory | Satisfactory |
| | 1,2,4-Trimethylbenzene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,2-Dichlorobenzene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,3,5-Trimethylbenzene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,3-Dichlorobenzene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 1,4-Dichlorobenzene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 2-Chlorotoluene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | 4-Chlorotoluene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Bromobenzene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Benzene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |

*(continued on next page)*

**Table F-7. Summary of Contract Laboratory Proficiency Test Results for Potable Water New York State Department of Health ELAP (CY 2000)** *(concluded)*.

| | | April 2000 | | | | May 2000 | October 2000 | | |
|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **BNL** | **GEL** | **H2M** | **STL- MO** | **H2M** | **BNL** | **H2M** | **STL- MO** |
| | Chlorobenzene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Ethyl benzene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Hexachlorobutadiene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | n-Butylbenzene | Satisfactory | Unsatisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | n-Propylbenzene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | o-Xylene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | p-isopropyltoluene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | sec-Butylbenzene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Toluene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Styrene | Satisfactory | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | tert-Butylbenzene | NT | Satisfactory | Satisfactory | Satisfactory | NT | Satisfactory | Satisfactory | Satisfactory |
| | Isopropylbenzene | NT | NT | NT | NT | NT | Satisfactory | Satisfactory | Unsatisfactory |
| | m-Xylene | NT | NT | NT | NT | NT | Satisfactory | Satisfactory | Satisfactory |
| Microextractables | | | | | | | | | |
| | 1,2-Dibromo-3-chloropropan | NT | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | NT |
| | 1,2-Dibromoethane | NT | Satisfactory | Satisfactory | NT | NT | NT | Satisfactory | NT |
| Mixed Pesticides I | | | | | | | | | |
| | Aldrin | NT | NT | Unsatisfactory | NT | NT | NT | Satisfactory | NT |
| | Dieldrin | NT | NT | Satisfactory | NT | NT | NT | Satisfactory | NT |
| | Endrin | NT | NT | Satisfactory | NT | NT | NT | Satisfactory | NT |
| | Hexachlorobenzene | NT | NT | Satisfactory | NT | NT | NT | Satisfactory | NT |
| | Hexachlorocyclopentadiene | NT | NT | Satisfactory | NT | NT | NT | Satisfactory | NT |
| | Heptachlor | NT | NT | Satisfactory | NT | NT | NT | Satisfactory | NT |
| | Heptachlor epoxide | NT | NT | Satisfactory | NT | NT | NT | Satisfactory | NT |
| | Lindane | NT | NT | Satisfactory | NT | NT | NT | Satisfactory | NT |
| | Methoxychlor | NT | NT | Satisfactory | NT | NT | NT | Satisfactory | NT |
| Mixed Esters | | | | | | | | | |
| | bis(2-Ethylhexyl)phthalate | NT | NT | Unsatisfactory | NT | NT | NT | Satisfactory | NT |
| Benzo(a)pyrene | | | | | | | | | |
| | Benzo(a)pyrene | NT | NT | Satisfactory | NT | NT | NT | NT | NT |
| Mixed Herbicides | | | | | | | | | |
| | 2,4-D | NT | NT | NT | NT | NT | NT | Satisfactory | NT |
| | 2,4,5-TP (Silvex) | NT | NT | NT | NT | NT | NT | Satisfactory | NT |
| Bacteriology | | | | | | | | | |
| | Total Coliform | NT | NT | NT | NT | Satisfactory | NT | NT | NT |
| | Plate Count | NT | NT | NT | NT | Satisfactory | NT | NT | NT |

Notes:
Refer to Calandar Year 2000 ASL Quality Assurance Report for detailed data
Result column provides ELAP evaluation of analytical performance which is based on 95 and 99% confidence interval about the target value.
NT = Not Tested

**Table F-8. Summary of Water Supply and Water Pollution Studies Environmental Resources Associates (ERA) (CY 2000).**

| | | STL | | | | BNL | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **WP-63** | **WP-66** | **WS-45** | **WP-69** | **WP-64** | **WP-70** | **WS-42** | **WS-52** |
| Minerals | | | | | | | | | |
| | Total Solids | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Total Dissolved Solids | Acceptable | NT | Acceptable | Acceptable | NT | NT | NT | NT |
| | Alkalinity | Acceptable | NT | NT | NT | NT | NT | NT | NT |
| | Chloride | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Potassium | Not Acceptable | Acceptable | Acceptable | Not Acceptable | NT | NT | NT | NT |
| | Sodium | Warning | NT | Acceptable | Not Acceptable | Not Acceptable | Warning | NT | NT |
| | Sulfate | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| Hydrogen Ion | pH | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| Hardness | | | | | | | | | |
| | Total Suspended Solids | Acceptable | NT | NT | NT | NT | NT | NT | NT |
| | Calcium | Warning | Acceptable | Acceptable | Acceptable | NT | NT | NT | NT |
| | Magnesium | Warning | Acceptable | Acceptable | Acceptable | NT | NT | NT | NT |
| Demand | | | | | | | | | |
| | Biological Oxygen Demand | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Total Organic Carbon | Acceptable | NT | Acceptable | Not Acceptable | NT | NT | NT | NT |
| Nutrients | | | | | | | | | |
| | Ammonia | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Nitrate | Acceptable | NT | Acceptable | Acceptable | NT | NT | Acceptable | Acceptable |
| | Ortho-phosohate | Warning | NT | Acceptable | Acceptable | NT | NT | NT | NT |
| Nitrite | | | | | | | | | |
| | Nitrite | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| Bromide | | | | | | | | | |
| | Bromide | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| Nutients-Complex | | | | | | | | | |
| | Total Phosphorous | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Total Kjeldahl Nitrogen | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Cyanide, total | Acceptable | NT | Acceptable | Acceptable | NT | NT | NT | NT |
| Phenolics | | | | | | | | | |
| | Phenolics, total | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| Grease & Oil | | | | | | | | | |
| | Grease & Oil (Gravametric) | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| Trace Metals | | | | | | | | | |
| | Aluminum | Acceptable | NT | Not Acceptable | Acceptable | Warning | Acceptable | Acceptable | Not Acceptable |
| | Antimony | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |

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**Table F-8. Summary of Water Supply and Water Pollution Studies Environmental Resources Associates (ERA) (CY 2000)** *(continued)*.

| | | STL | | | | BNL | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **WP-63** | **WP-66** | **WS-45** | **WP-69** | **WP-64** | **WP-70** | **WS-42** | **WS-52** |
| | Arsenic | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Barium | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| Cyanide | | | | | | | | | |
| | Beryllium | Acceptable | NT | Acceptable | Acceptable | Not Acceptable | Acceptable | Acceptable | Acceptable |
| | Cadmium | Acceptable | NT | Acceptable | Acceptable | Acceptable | Warning | Acceptable | Acceptable |
| | Chromium | Acceptable | NT | Acceptable | Acceptable | Acceptable | Warning | Acceptable | Acceptable |
| | Cobalt | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Copper | Acceptable | NT | Acceptable | Acceptable | Acceptable | Warning | Not acceptable | Not acceptable |
| | Iron | Acceptable | NT | Acceptable | Acceptable | Acceptable | Warning | Acceptable | Acceptable |
| | Lead | Acceptable | NT | Acceptable | Acceptable | Acceptable | Not acceptable | Acceptable | Acceptable |
| | Magnesium | Acceptable | NT | Acceptable | Acceptable | NT | NT | NT | NT |
| | Manganese | NT | NT | NT | NT | Warning | Not acceptable | NT | NT |
| | Molybdenum | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Not acceptable |
| | Nickel | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Selenium | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Silver | Acceptable | NT | Acceptable | Acceptable | Acceptable | Check for Error | Acceptable | Acceptable |
| | Thallium | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Vanadium | Acceptable | NT | Acceptable | Acceptable | Warning | Acceptable | NT | Not acceptable |
| | Zinc | Acceptable | NT | Acceptable | Acceptable | Acceptable | Warning | Not acceptable | Not acceptable |
| | Mercury | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| Volatiles | | | | | | | | | |
| | Acetone | Acceptable | NT | NT | Acceptable | Acceptable | Acceptable | NT | NT |
| | Acrylonitrile | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Acrloien | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Benzene | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Bromodichloromethane | Acceptable | NT | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Bromoform | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | 2-Butanone | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | NT | NT |
| | Bromomethane | Acceptable | NT | Not Acceptable | Acceptable | Acceptable | Acceptable | NT | NT |
| | Carbon disulfide | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Carbon tetrachloride | Acceptable | NT | Not Acceptable | Acceptable | Acceptable | NT | Acceptable | Acceptable |
| | Chlorobenzene | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Chlorodibromomethane | Acceptable | NT | Acceptable | Acceptable | Not acceptable | Acceptable | Acceptable | Acceptable |
| | Chloroethane | Acceptable | NT | Not Acceptable | Acceptable | Acceptable | Acceptable | NT | NT |
| | EDB | Acceptable | NT | Acceptable | Acceptable | NT | NT | NT | NT |
| | Dibromomethane | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | 1,2-Dichlorobenzene | Acceptable | NT | Acceptable | Acceptable | Acceptable | Not acceptable | Acceptable | Acceptable |
| | 1,3-Dichlorobenzene | Acceptable | NT | Acceptable | Acceptable | Warning | Not acceptable | NT | NT |
| | 1,4-Dichlorobenzene | Acceptable | NT | Acceptable | Acceptable | Acceptable | Warning | Acceptable | Acceptable |
| | Dichlorodifluoromethane | Acceptable | NT | Not Acceptable | Acceptable | NT | NT | NT | NT |

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**Table F-8. Summary of Water Supply and Water Pollution Studies Environmental Resources Associates (ERA) (CY 2000)** *(continued)*.

| | | STL | | | | BNL | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **WP-63** | **WP-66** | **WS-45** | **WP-69** | **WP-64** | **WP-70** | **WS-42** | **WS-52** |
| | 1,1-Dichloroethane | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | NT | NT |
| | 1,2-Dichloroethane | Acceptable | NT | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | 1,1-Dichloroethene | Acceptable | NT | Not Acceptable | Acceptable | NT | NT | Acceptable | Acceptable |
| | cis-1,2-Dichloroethylene | Acceptable | NT | Acceptable | Acceptable | NT | Acceptable | Acceptable | Acceptable |
| | trans-1,2-Dichloroethylene | Acceptable | NT | Not Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | 1,2-Dichloropropane | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | cis-1,3-Dichloropropene | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | NT | NT |
| | trans-1,3-Dichloropropene | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | NT | NT |
| | Ethylbenzene | Acceptable | NT | Acceptable | Acceptable | Warning | Warning | Acceptable | Acceptable |
| | 2-Hexanone | Acceptable | NT | NT | Acceptable | Acceptable | Acceptable | NT | NT |
| | Methylene chloride | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Methyl iso butyl ketone | Acceptable | NT | NT | Acceptable | Acceptable | Acceptable | NT | NT |
| | Styrene | Acceptable | NT | Acceptable | Acceptable | NT | NT | Acceptable | Acceptable |
| | 1,1,1,2-Tetrachloroethane | Acceptable | NT | Acceptable | Acceptable | NT | NT | NT | NT |
| | 1,1,2,2-Tetrachloroethane | Acceptable | NT | Not Acceptable | Acceptable | Acceptable | Acceptable | NT | NT |
| | Tetrachloroethene | Acceptable | NT | Not Acceptable | Acceptable | Acceptable | Warning | Acceptable | Acceptable |
| | Toluene | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | 1,1,1-Trichloroethane | Acceptable | NT | Not Acceptable | Acceptable | Acceptable | Not acceptable | Acceptable | Acceptable |
| | 1,1,2-Trichloroethane | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Trichloroethene | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Trichlorofluoromethane | Acceptable | NT | NT | Acceptable | Acceptable | Acceptable | NT | NT |
| | Vinyl chloride | Acceptable | NT | Not Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Xylenes, total | Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | 1,2,4-Trichlorobenzene | NT | NT | Acceptable | NT | NT | NT | Acceptable | Acceptable |
| | Chloroform | NT | NT | Not Acceptable | NT | Acceptable | Acceptable | Acceptable | Acceptable |
| | Total Trihalomethanes | NT | NT | Acceptable | NT | NT | NT | Acceptable | Acceptable |
| | Bromobenzene | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | Bromochloromethane | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | n-Butylbenzene | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | sec-Butylbenzene | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | tert-Butylbenzene | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | methyl-tert-Butyl Ether | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | Chloromethane | NT | NT | Not Acceptable | NT | Acceptable | Acceptable | NT | NT |
| | 2-Chlorotoluene | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | 4-Chlorotoluene | NT | NT | Not Acceptable | NT | NT | NT | NT | NT |
| | 1,3,-Dichloropropane | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | 2,2-Dichloropropane | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | 1,1-Dichloropropene | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | Hexachlorobutadiene | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | Isopropylbenzene | NT | NT | Acceptable | NT | NT | NT | NT | NT |

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**Table F-8. Summary of Water Supply and Water Pollution Studies Environmental Resources Associates (ERA) (CY 2000)** *(continued)*.

| | | STL | | | | BNL | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **WP-63** | **WP-66** | **WS-45** | **WP-69** | **WP-64** | **WP-70** | **WS-42** | **WS-52** |
| | 4-Isopropyltoluene | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | n-Butylbenzene | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | n-Propylbenzene | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | 1,2,3-Trichlorobenzene | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | 1,2,3-Trichloropropane | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| | 1,2,4-Trimethylbenzene | NT | NT | Acceptable | NT | NT | NT | NT | NT |
| PCBs in Water | | | | | | | | | |
| | Aroclor 1242 Quantitation | Acceptable | NT | NT | NT | NT | NT | NT | NT |
| | Aroclor 1242 Identification | Acceptable | NT | NT | NT | NT | NT | NT | NT |
| | Aroclor 1260 Quantitation | Not Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Aroclor 1260 Identification | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Aroclor 1448 Quantitation | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Aroclor 1448 Identification | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| PCBs in Oil | | | | | | | | | |
| | Aroclor 1254 Quantitation | Acceptable | NT | NT | Acceptable | Acceptable | Acceptable | NT | NT |
| | Aroclor 1254 Identification | Acceptable | NT | NT | Acceptable | Acceptable | Acceptable | NT | NT |
| | Aroclor 1242 Quantitation | Acceptable | NT | NT | NT | NT | NT | NT | NT |
| | Aroclor 1242 Identification | Acceptable | NT | NT | NT | NT | NT | NT | NT |
| | Aroclor 1016/1242 Quantitation | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Aroclor 1016/1242 Identification | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Aroclor 1260 | NT | NT | NT | NT | Acceptable | Acceptable | NT | NT |
| | Aroclor 126 identification | NT | NT | NT | NT | Acceptable | Acceptable | NT | NT |
| Pesticides | | | | | | | | | |
| | Aldrin | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Alpha-BHC | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | beta-BHC | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | delta-BHC | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | gamma-BHC (Lindane) | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | alpha-Chlordane | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | gamma-Chlordane | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | 4,4'-DDD | Acceptable | NT | NT | Not Acceptable | NT | NT | NT | NT |
| | 4,4'-DDE | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | 4,4'-DDT | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Dieldrin | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Endrin | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Endrin Aldehyde | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Endrin ketone | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Endosulfan I | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |

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**Table F-8. Summary of Water Supply and Water Pollution Studies Environmental Resources Associates (ERA) (CY 2000)** *(continued)*.

| Category | Analyte | STL | | | | BNL | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | WP-63 | WP-66 | WS-45 | WP-69 | WP-64 | WP-70 | WS-42 | WS-52 |
| | Endosulfan II | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Endosulfan sulfate | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Heptachlor | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Heptachlo epoxide | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| | Methoxychlor | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| Chlordane | | | | | | | | | |
| | Chlordane, technical | Acceptable | NT | NT | Acceptable | NT | NT | NT | NT |
| Base Neutrals | | | | | | | | | |
| | Acenaphthene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Acenaphthylene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Analine | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Anthracene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Benzidine | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Benzo(a)anthracene | NT | NT | NT | Not Acceptable | NT | NT | NT | NT |
| | Benzo(b)fluoranthene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Benzo(k)fluoranthene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Benzo(g,h,I)perylene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Benzo(a)pyrene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Benzyl alcohol | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 4-Bromophenyl-phenyl ether | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Butylbenzylphthalate | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 4-Chloroanaline | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | bis(2-Chloroethoxy)methane | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | bis(2-Chloroethyl)ether | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | bis(2-Chloroisopropyl)ether | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 2-Chloronaphthalene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 4-Chlorophenyl-phenylether | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Chrysene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Dibenz(a,h)anthracene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Dibenzofuran | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Di-n-butyl phthalate | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 1,2-Dichlorobenzene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 1,3-Dichlorobenzene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 1,4-Dichlorobenzene | NT | NT | NT | Not Acceptable | NT | NT | NT | NT |
| | 3,3'-Dichlorobenzidine | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Diethylphthalate | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Dimethylphthalate | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 2,4-Dinitrotoluene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 2,6-Dinitrotoluene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Di-n-octyl phthalate | NT | NT | NT | Acceptable | NT | NT | NT | NT |

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**Table F-8. Summary of Water Supply and Water Pollution Studies Environmental Resources Associates (ERA) (CY 2000)** *(concluded)*.

| | | STL | | | | BNL | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Category** | **Analyte** | **WP-63** | **WP-66** | **WS-45** | **WP-69** | **WP-64** | **WP-70** | **WS-42** | **WS-52** |
| | bis(2-Ethylhexyl)phthalate | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Fluoranthene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Fluorene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Hexachlorobenzene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Hexachlorobutadiene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Hexachlorocyclopentadiene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Hexachloroethane | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Indeno(1,2,3-cd)pyrene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Isophorone | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 1-Methylnaphthalene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 2-Methylnaphthalene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Naphthalene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 2-Nitroanaline | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 3-Nitroanaline | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 4-Nitroanaline | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Nitrobenzene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | N-Nitrosodimethylamine | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | N-Nitrosodiphenylamine | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | N-Nitroso-di-n-propylamine | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Phenanthrene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Pyrene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Pyridine | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 1,2,4-Trichlorobenzene | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| Acids | | | | | | | | | |
| | 2-Chlorophenol | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 2,4-Dimethylphenol | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 2,4-Dinotrophenol | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 2-Methylphenol | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 3-Methylphenol | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 4-Methylphenol | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 2-Nitrophenol | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 4-Nitrophenol | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Pentachlorophenol | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | Phenol | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 2,4,5-Trichlorophenol | NT | NT | NT | Acceptable | NT | NT | NT | NT |
| | 2,4,6-Trichlorophenol | NT | NT | NT | Acceptable | NT | NT | NT | NT |

Notes:
Refer to Calandar Year 2000 ASL Quality Assurance Report for detailed data
Result column provides ERA evaluation of analytical performance which is based on 95 and 99% confidence interval about the target value.
NT = Not Tested