

Introduction

Each year, Brookhaven National Laboratory (BNL), a multi-program national laboratory, prepares an annual Site Environmental Report (SER) in accordance with Order 231.1A, Environment, Safety and Health Reporting, of the U.S. Department of Energy (DOE). The SER is written to inform outside regulators, the public, and Laboratory employees of BNL's environmental performance during the calendar year in review, and to summarize BNL's on-site environmental data; environmental management performance; compliance with applicable DOE, Environmental Protection Agency (EPA), state, and local regulations; and environmental, restoration, and surveillance monitoring programs. BNL has prepared annual SERs since 1971 and has documented nearly all of its environmental history since the Laboratory's inception in 1947.

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

This chapter describes the Laboratory's facilities, ecological resources, demographics, and history. It also discusses local characteristics in terms of geology, hydrology, and climate, providing background material for the technical information in the chapters that follow. The appendices provide additional data and information and are intended to assist the reader to better understand the content of this report.

1.1 LABORATORY MISSION

Brookhaven National Laboratory's broad mission is to produce excellent science in a safe, environmentally sound manner with the cooperation, support, and appropriate involvement of the scientific and local communities. For more than 50 years, BNL has been one of the leading research institutions in the nation and the world. Much of the Laboratory's effort is directed at the study of the basic nature of matter, including subatomic particles and the structure of the atom. BNL research has also produced extraordinarily useful technology. To date, six Nobel Prizes have been awarded for research conducted at BNL, as well as numerous patents.

The Laboratory plays a lead role in the DOE Science and Technology mission and contributes to the DOE missions in Energy Resources, Environmental Quality, and National Security. The fundamental elements of BNL's role in support of these key DOE missions are:

- To conceive, design, construct, and operate complex, leading-edge, user-oriented research facilities in response to the needs of DOE and the international community of users.
- To carry out basic and applied research in long-term, high-risk programs at the frontier of science.
- To develop advanced technologies that address national needs and to transfer them

to other organizations and to the commercial sector.

- To disseminate technical knowledge, to educate new generations of scientists and engineers, to maintain technical capabilities in the nation's workforce, and to encourage scientific awareness in the general public.

BNL integrates environmental stewardship into all facets of its missions and operations. The Environmental Stewardship Policy, which is posted throughout the site, reflects BNL's commitment to conducting research and operational activities in a manner that protects the health of the public, employees, and the environment.

1.2 OPERATIONS AND RESEARCH

Established in 1947, BNL is a national laboratory operated for DOE by Brookhaven Science Associates (BSA), 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 to 1998, BNL was operated by Associated Universities Incorporated. Prior to 1947, the site was operated as Camp Upton, a U.S. Army training camp, which was active from 1917 to 1920 during World War I and from 1940 to 1946 during World War II. Many of the cultural resources from the Army era are preserved in the Camp Upton Museum and are discussed in Chapter 6.

Owned and primarily funded by DOE, BNL conducts applied research in the physical, biomedical, and environmental sciences, and in energy technologies. BNL also builds and operates major world-class research facilities that are available to university, industrial, and government personnel. Approximately 3,000 scientists, engineers, technicians, and support staff work at BNL, and more than 4,000 guest researchers from all over the world visit the site each year to participate in scientific collaborations. Some important scientific discoveries and research at BNL include major discoveries in particle physics; the use of L-dopa to treat

Parkinson's disease; work on magnetically levitated (Maglev) trains; the radionuclide thallium-201, used in millions of heart stress tests each year; X-ray angiography for noninvasive heart imaging; and pioneering solar neutrino studies seeking the answer to the mystery of the "missing" neutrinos from our solar system's sun, and neutrino bursts from supernovae. Some topics of research now being conducted at the Laboratory include pollution-eating bacteria; structural studies of the Lyme disease protein for developing new vaccines; asbestos-digesting foam; large-scale studies of the effect of increased carbon dioxide on ecosystems; promising cocaine addiction treatments; and cleaner, more efficient oil burners.

1.3 HISTORY

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

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. In the past three decades, BNL has helped pioneer development of a powerful medical imaging technique known as Positron Emission Tomography (PET). This technology has since provided a view of the body's inner workings for doctors treating millions of patients and performing medical research worldwide. 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 medical facilities are currently operating. Due to a reduction of research funding, the BMRR was shut down in December 2000. All spent fuel from the BMRR has been removed and transported to the Savannah River Laboratory.

High-energy particle physics research at BNL began in 1952 with the Cosmotron, the first particle accelerator to achieve billion-electron-volt energies. Work at the Cosmotron resulted in a Nobel Prize-winning discovery in 1957. In 1960, the Alternating Gradient Synchrotron (AGS), a much larger accelerator that surpassed the Cosmotron's capabilities, became operational. The AGS, still in operation, has yielded many discoveries of new particles and phenomena, for which BNL researchers were awarded three Nobel Prizes in Physics in 1976, 1980, and 1988. The Tandem Van de Graaff accelerator, also still in use, began operating in 1970 and is the starting point of the chain of accelerators that provide ions of gold and other heavy metals for experiments at the Relativistic Heavy Ion Collider (RHIC). In 1982, researchers began using the National Synchrotron Light Source (NSLS), which guides charged particles in orbit inside a donut-shaped electron storage ring for use in a wide range of physical and biological experiments.

The RHIC, the Laboratory's newest two-ringed particle accelerator, began operation in 2002. The four RHIC detectors record full-energy collisions that recreate (on a microscopic scale) the hot, dense conditions that are thought to have existed when the universe first formed. This enables scientists to study the basic

components of matter as they existed in their earliest forms. In August 1999, the RHIC became the first facility at BNL and also on Long Island to receive International Organization for Standardization (ISO) 14001 Environmental Management System certification, which is discussed in Chapter 2. The RHIC is an example of BNL's commitment to fully integrate today's world-class science with world-class protection of the environment.

Historical operations and past waste management practices at the Laboratory resulted in the release of chemicals and radioactive materials that led to soil and groundwater contamination. In 1989, BNL was added to the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) National Priorities List of contaminated sites identified for priority cleanup, one of 27 such sites on Long Island. Since then, BNL has made significant progress toward improving environmental operations and remediating past contamination.

1.4 LOCATION, LOCAL POPULATION, AND LOCAL ECONOMY

BNL is located in Suffolk County on Long Island, New York, about 60 miles east of New York City. The Laboratory's 5,265-acre site is near Long Island's geographic center and is part of the Town of Brookhaven, the largest township (both in area and population) in Suffolk County. Approximately 150 people live in apartments and cottages on site, and many of the approximately 4,000 scientists and students who visit each year stay in the Laboratory's dormitories. More than 75 percent of BNL's approximately 3,000 employees live within a 15-mile radius of the site.

BNL is the largest employer on eastern Long Island, with an annual budget approaching \$443 million. Employee salaries, wages, and fringe benefits account for almost 62 percent of that amount. Additionally, this budget directly supports the local economy through purchases of materials and services. An independent Suffolk County Planning Commission concluded that BNL's spending for operations, procurement, payroll, construction, medical benefits, and

technology transfer spreads throughout Long Island's economy, making BNL vital to the local economic health (Kamer 1995).

1.5 FACILITIES AND OPERATIONS

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

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

The balance of the site, approximately 3,600 acres, is mostly wooded and represents the native Pine Barrens ecosystem. In November 2000, DOE set aside 530 acres of undeveloped land at BNL as the Upton Ecological and Research Reserve. Additional information regarding the "Upton Reserve" and BNL's natural resources can be found in Section 1.8 of this chapter and in Chapter 6.

The major scientific facilities at BNL are pictured and briefly described in Figure 1-1. The three former research reactors, no longer operational, are discussed in Section 1.2. Numerous other facilities, shown in Figure 1-2 and briefly described below, support BNL's science and technology mission by providing basic utility and environmental services.

- *Water Treatment Plant (WTP)*. The potable water treatment facility has a capacity of 5 million gallons per day. Potable water is obtained from six on-site wells. Three wells located along the western boundary of the site are treated with a lime softening process to remove naturally occurring iron. The plant is also equipped with dual air-stripping towers to ensure that volatile organic compounds (VOCs) are at or below New York State drinking water standards. Three wells located along the eastern section of the developed site are treated with carbon

to ensure that VOC levels meet the drinking water standards.

- *Central Chilled Water Plant*. This facility provides chilled water sitewide for air conditioning and process refrigeration via underground piping. The plant has a large refrigeration capacity with once-through cooling, and reduces the need for local refrigeration plants.
- *Central Steam Facility (CSF)*. This plant provides high-pressure steam for facility and process heating sitewide. Either natural gas or fuel oil can be used to produce the steam, which is conveyed to other facilities through underground piping. Condensate is collected and returned to the CSF for reuse, to conserve water and energy.
- *Major Petroleum Facility (MPF)*. This facility provides reserve fuel for the CSF during times of peak operation. With a total capacity of 2.3 million gallons, the MPF primarily stores No. 6 fuel oil. The 1997 conversion of the CSF boilers to burn natural gas as well as oil has significantly reduced BNL's reliance on oil as a fuel source.
- *Sewage Treatment Plant (STP)*. This facility treats sanitary and certain process wastewater from BNL facilities prior to discharge into the Peconic River, similar to the operations of a municipal sewage treatment plant. The plant has a design capacity of 3 million gallons per day. Effluent is monitored and controlled under a permit issued by the New York State Department of Environmental Conservation (NYSDEC).
- *Waste Management Facility (WMF)*. This facility is a state-of-the-art complex for managing the wastes generated from BNL's research and operations activities. The facility was built with advanced environmental protection systems and features, and began operation in December 1997.
- *Fire Station*. The BNL Fire Rescue Group provides on-site fire suppression, emergency medical services, hazardous material response, salvage, and damage control. The Fire Station houses six response vehicles. The fire rescue group responds within five

minutes to any emergency in the core area of the Laboratory and within eight minutes to emergencies in the outer areas (RHIC and eastern portions of the site).

1.6 GEOLOGY AND HYDROLOGY

BNL is situated on the western rim of the shallow Peconic River watershed. The marshy areas in the northern and eastern sections of the site are part of the headwaters of the Peconic River. Depending on the height of the water table relative to the base of the riverbed, the Peconic River both recharges to, and receives water from, the sole source aquifer system beneath Long Island. In times of sustained drought, the river water typically recharges to the groundwater; with normal to above-normal precipitation, the river receives water from the aquifer. Due to the high rate of precipitation in 2003, the Peconic River flowed off site the entire year.

In general, the terrain of the BNL site is gently rolling, with elevations varying between 44 and 120 feet above mean sea level. Depth to groundwater from the surface of the land ranges from 5 feet near the Peconic River to about 80 feet in the higher elevations of the central and western portions of the site. The hydrology of the local area is well defined. Studies of Long Island hydrology and geology in the vicinity of the Laboratory indicate that the uppermost Pleistocene deposits, composed of highly permeable glacial sands and gravel, are between 120 and 250 feet thick (Warren et al. 1968, Scorca et al. 1999). Water penetrates these deposits readily and there is little direct runoff into surface streams unless precipitation is intense. These sandy deposits store large quantities of water in the Upper Glacial Aquifer. On average, about half of the annual precipitation is lost to the atmosphere through evapotranspiration and the other half percolates through the soil to recharge the groundwater (Koppelman 1978). The area has a high average recharge rate (22 inches 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,

Suffolk County Department of Health Services 1987). Precipitation and surface water that recharge within this zone have the potential to replenish the deep Magothy and Lloyd aquifer systems lying below the Upper Glacial Aquifer. Experts estimate that up to two-fifths of the recharge from rainfall moves into the deeper aquifers. The extent to which groundwater on site contributes to deep flow recharge has been confirmed through the use of an extensive network of shallow and deep wells installed at BNL and surrounding areas (Geraghty and Miller 1996). This groundwater system is the primary source of drinking water for both on- and off-site private and public supply wells and has been designated a sole source aquifer system by the Environmental Protection Agency. BNL uses approximately 1.8 million gallons of groundwater per day to meet potable water needs and heating and cooling requirements. Approximately 75 percent of the water pumped from BNL supply wells is returned to the aquifer through on-site recharge basins and permitted discharges to the Peconic River. Under normal hydrologic conditions, most of the water discharged to the river recharges to the Upper Glacial Aquifer before leaving the BNL site. Human consumption, evaporation (cooling tower and wind losses), and sewer line losses account for the remaining 25 percent. An additional 3.5 million gallons of groundwater are pumped each day from remediation wells for treatment and then returned to the aquifer by way of recharge basins.

Groundwater flow direction across the BNL site is influenced by natural drainage systems moving eastward along the Peconic River, southeast toward the Forge River, and south toward the Carmans River (Figure 1-3). Pumping from on-site supply wells affects the direction and speed of groundwater flow, especially in the central, developed areas of the site. The main groundwater divide on Long Island is aligned generally east-west, and lies approximately one-half mile north of BNL. Groundwater north of the divide flows northward and ultimately discharges to the Long Island Sound. Groundwater south of the divide flows east and south, discharging to the Peconic River, Peconic



- and advanced medical radiotherapy techniques.
- 1. RELATIVISTIC HEAVY ION COLLIDER (RHIC)**
RHIC is one of the world's largest and most powerful accelerators. RHIC drives two intersecting beams of gold ions head-on, to form a subatomic collision. What physicists learn from these collisions may help us understand more about why the physical world works the way it does, from the smallest subatomic particles, to the largest stars.
 - 2. ALTERNATING GRADIENT SYNCHROTRON (AGS)**
The AGS is used for high-energy physics research. It accelerates protons to energies up to 30 GeV, and heavy-ion beams to 15 GeV. A 200 MeV Linear Accelerator (Linac), described below, serves as a proton injector for the AGS booster and also supplies a continuous beam of protons for radionuclide production by spallation reactions in the Brookhaven Linac Isotope Producer (BLIP) 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 AGS 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 on new diagnostic and therapeutic radiopharmaceuticals.
 - 5. HEAVY ION TRANSFER LINE (HITL)**
The HITL connects the Tandem Van de Graaff and the AGS Booster. This interconnection permits ions of intermediate mass to be injected into the AGS, where they can be accelerated to an energy of 15 GeV. 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 and therapy. It produced neutrons in an optimal energy range for experimental treatment of a type of brain cancer known as glioblastoma multiforme. The BMRR was shut down in December 2000.
 - 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 Booster for physics experiments.
 - 12. BROOKHAVEN GRAPHITE RESEARCH REACTOR (BGRR)**
No longer in operation, the BGRR was used for scientific exploration in the fields of medicine, biology, chemistry, physics, and nuclear engineering. The BGRR is currently being decommissioned.

Figure 1-1. Major Scientific Facilities at Brookhaven National Laboratory.



Figure 1-2. Major Laboratory Support and Services Facilities.

Bay, south shore streams, the Great South Bay, and the Atlantic Ocean. The regional groundwater flow system is discussed in greater detail in *Stratigraphy and Hydrologic Conditions* (Scorca et al. 1999). In most areas at BNL, the horizontal velocity of groundwater is approximately 0.75 to 1.2 feet per day (Geraghty and Miller 1996). In general, this means that groundwater travels for approximately 20 to 22 years as it moves from the central, developed area of the site to the BNL southern boundary.

1.7 CLIMATE

The Meteorological Group at BNL has been recording on-site weather data since 1949. The prevailing ground-level winds at BNL are from the southwest during the summer, from the northwest during the winter, and about equally from these two directions during the spring and fall (Nagle 1975, 1978). Figure 1-4 shows the 2003 annual wind rose for BNL, which depicts the annual frequency distribution of wind speed and direction, measured at an on-site meteorological station.

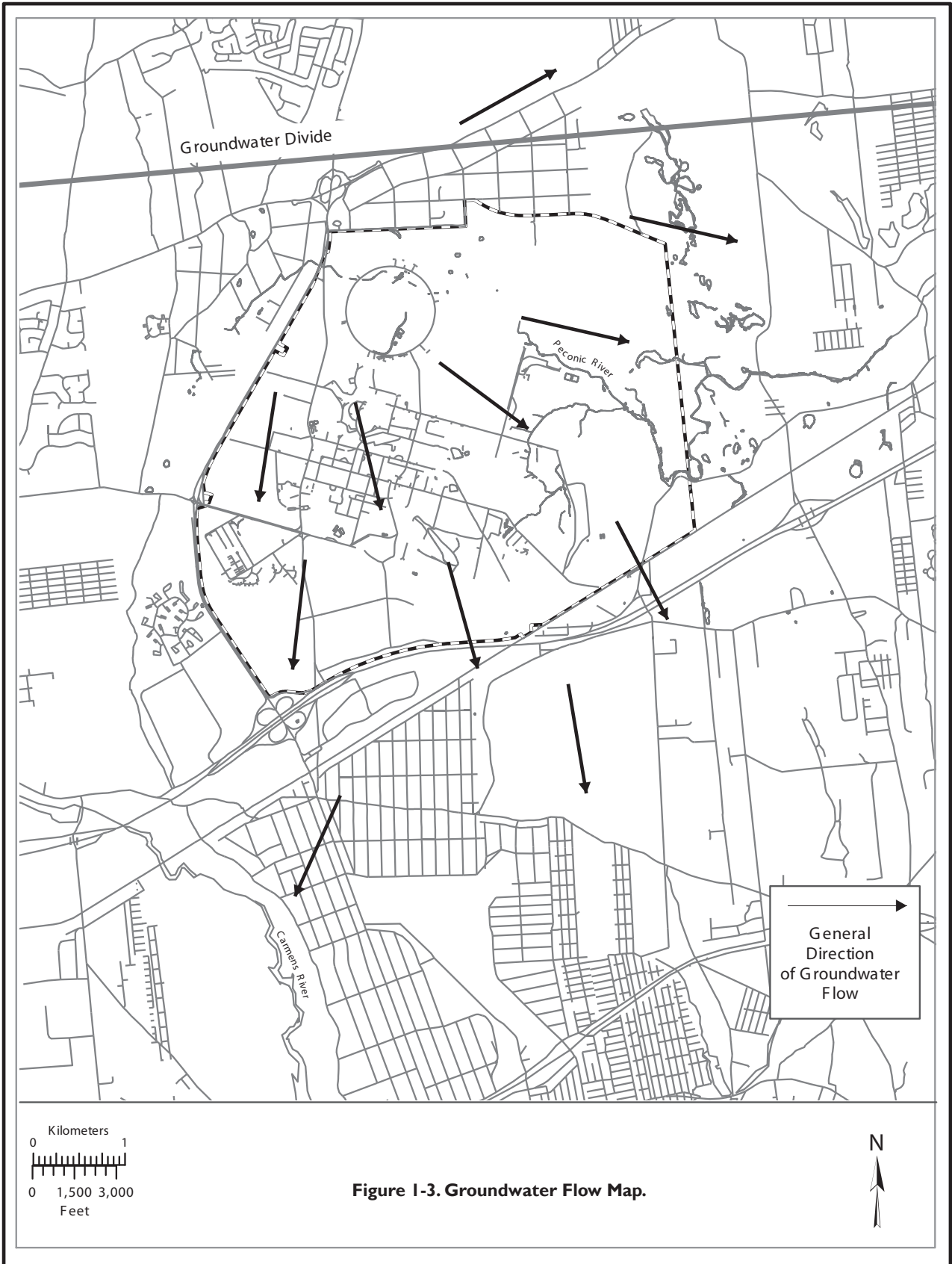
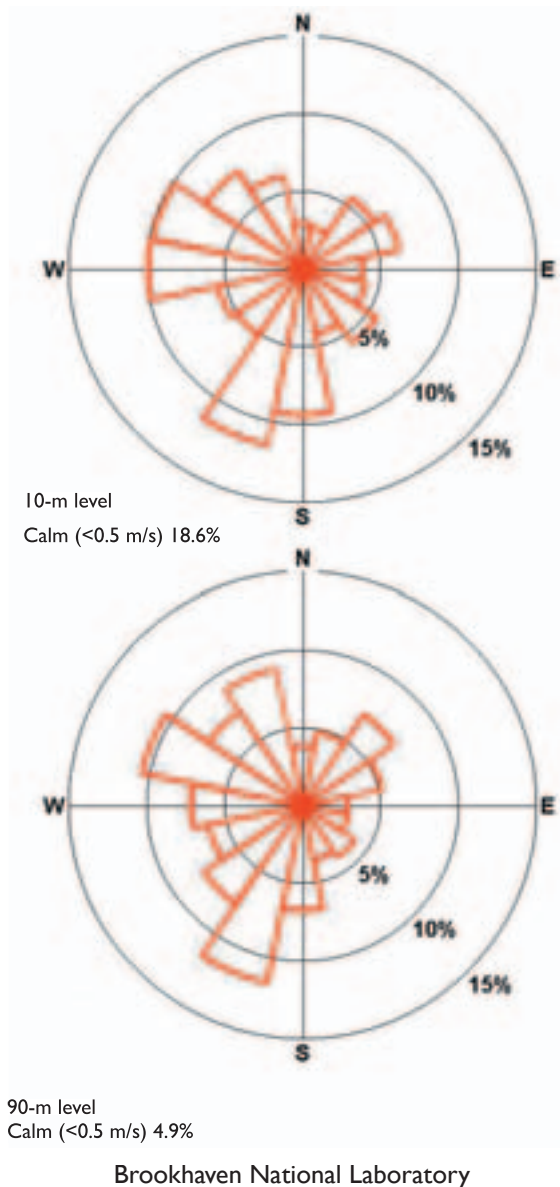


Figure I-3. Groundwater Flow Map.



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

Figure I-4. Annual Wind Rose (2003).

logical tower at heights of 33 feet (10 meters) and 300 feet (90 meters).

The average annual snowfall for BNL is 29.6 inches. February and December 2003 snowfalls, 31.8 inches and 25.0 inches respectively, were the second and third largest snow periods recorded at the Laboratory, and the winter of 2002–2003 was the fifth snowiest winter in 56

years. The average yearly precipitation at BNL for 2003 was 63.11 inches, making it the third wettest year recorded. In June, 12.28 inches of rain fell, making it the second wettest month recorded. Figures 1-5 and 1-6 show the 2003 monthly and the 55-year annual precipitation data.

The average temperature for 2003 was 50.8°F, only 0.7 degrees above the overall average for the past 56 years. Five new record-high daily temperatures and one new record-low daily temperature occurred in 2003. The record low temperature of 4.5°F was set on March 7. On March 17, a new high was set, when the temperature rose to 72°F. August was the hottest month on record, with an average monthly temperature of 74.6°F. Figures 1-7 and 1-8 show the 2003 temperatures and the historical annual mean temperatures.

1.8 ECOLOGICAL RESOURCES

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

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

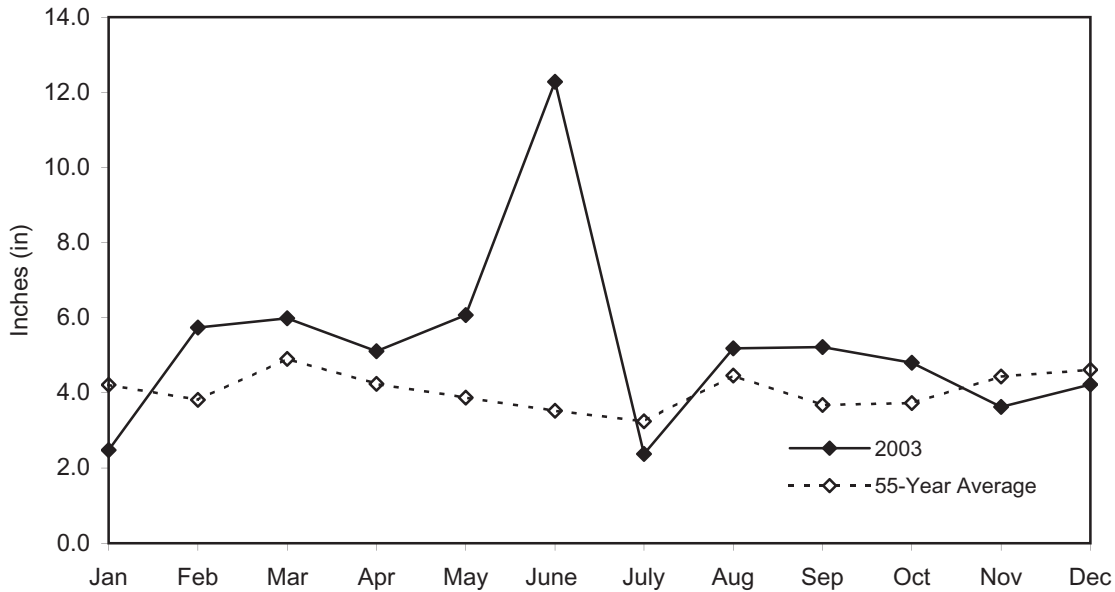


Figure I-5. 2003 Monthly Precipitation Versus 55-Year Monthly Average.

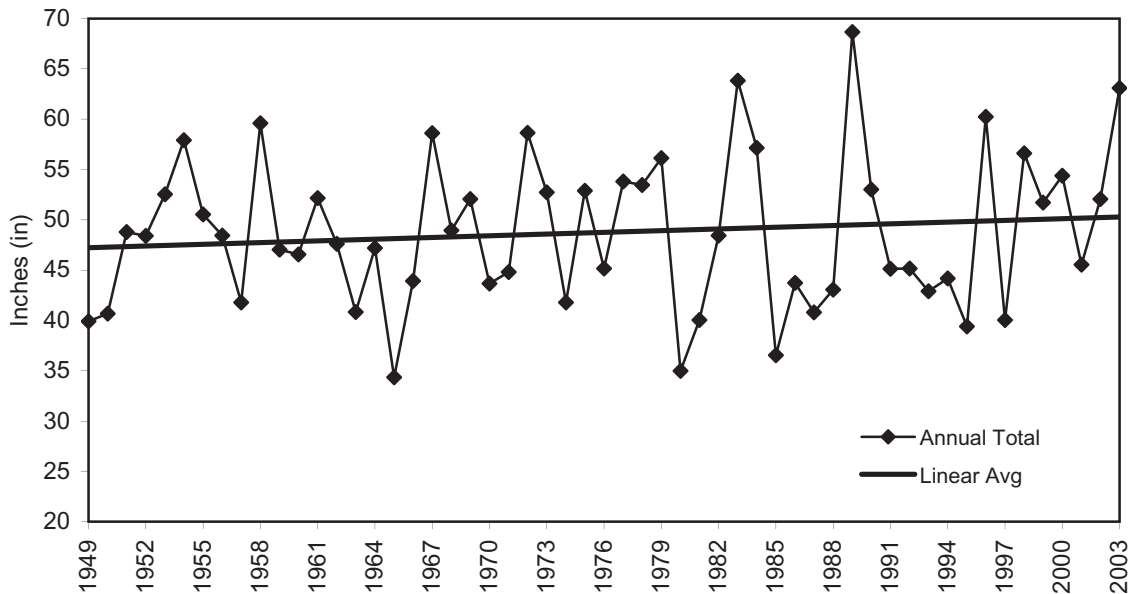


Figure I-6. Annual Precipitation Trend (55 Years).

More than 230 plant species have been identified on site, including one New York State threatened species and two that are rare.

The animal species identified at BNL include a number that are protected in New York State, as well as species common to mixed hardwood forests and open grassland habitats. At least 85 species of birds are known to nest at BNL, and more than 216 species have been docu-

mented as visiting the site. These numbers can be attributed to BNL's location in the Atlantic Flyway and to the habitats that offer food and rest to migratory songbirds. Permanently flooded retention basins and other watercourses support amphibians and aquatic reptiles. Nine fish, 13 amphibian, and 13 reptile species have been identified at BNL. Two types of butterflies that are protected in New York are believed to

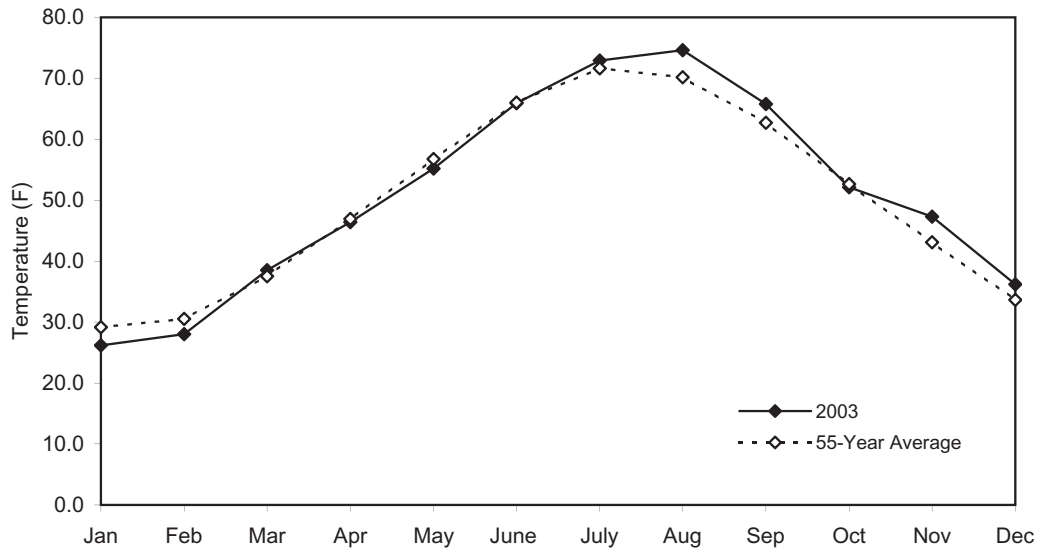


Figure I-7. 2003 Monthly Mean Temperature Versus 55-Year Monthly Average.

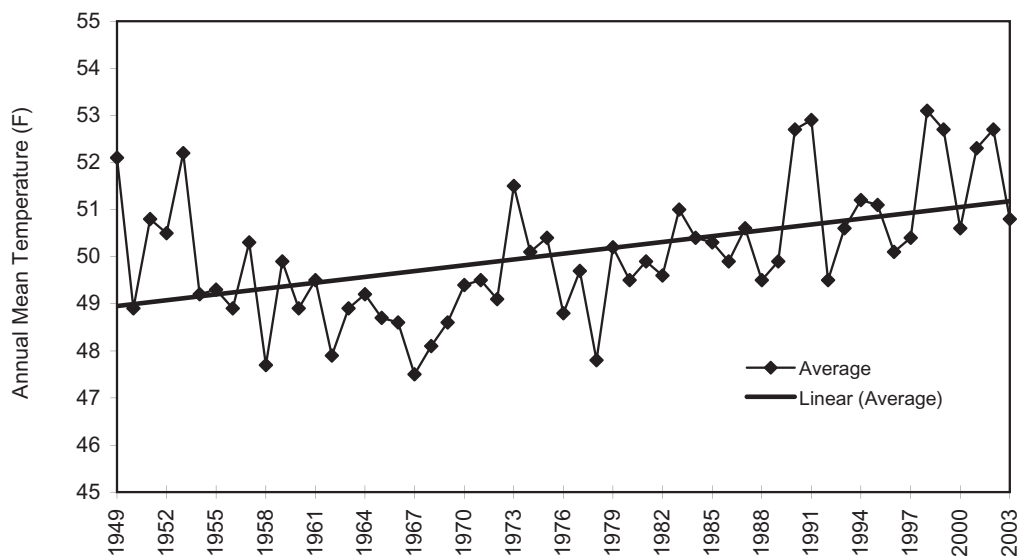


Figure I-8. Annual Mean Temperature Trend (55 Years).

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

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

a unique ecosystem of forests and wetlands that provide habitats for plants, mammals, birds, reptiles, and amphibians, some of which are endangered, threatened, or of special concern. Under an Inter-Agency Agreement with DOE, the U.S. Fish & Wildlife Services (FWS) conducts resource management programs for the conservation, enhancement, and restoration of wildlife and habitat in the Reserve. The Upton Reserve Technical Advisory Group (TAG), made up of local land management agencies,

assists BNL and FWS with technical expertise and helps determine policy for the Reserve.

As part of DOE's commitment to protecting the environmental assets of its sites, the agency agreed to provide FWS with \$200,000 per year for a five-year period to conduct land management activities and research at the Reserve. In 2003, this funding helped support activities in community outreach, conservation, and habitat protection. Three grants, selected by the TAG, were also awarded to support research relating to the Pine Barrens. In 2003, working with the TAG, regulatory agencies, and other stakeholders, BNL developed a comprehensive, ecosystem-based Natural Resource Management Plan for BNL and the Reserve. This plan provides management guidance, promotes stewardship of the natural resources found at BNL, and integrates environmental protection with pursuit of the Laboratory's mission. See Chapter 6 for details on BNL's natural resources.

REFERENCES AND BIBLIOGRAPHY

- DOE Order 231.1.A. 2003. Environment, Safety and Health Reporting. U.S. Department of Energy, Washington, DC.
- Geraghty and Miller, Inc. 1996. Regional Groundwater Model, Brookhaven National Laboratory, Upton, New York. A Report to Brookhaven National Laboratory. November 1996.
- Kamer, Pearl. 1995. The Impact of Brookhaven National Laboratory on the Long Island Economy. Suffolk County Planning Commission, Suffolk County Department of Planning, June 1995.
- Koppelman, L.E. 1978. *The Long Island Comprehensive Waste Treatment Management Plan* (Long Island 208 Study), Volumes I and II. Long Island Regional Planning Board, Hauppauge, NY. July 1978.
- Meinhold, C.B., and A.P. Hull. 1998. Radiological Environmental Monitoring Report for Brookhaven National Laboratory, 1967–1970. DOE Contract No. DE-AC02-98CH10866. Brookhaven National Laboratory, Upton, NY. October 1998.
- Meinhold, C.B., and A.F. Meinhold. 2001. Radiological Emissions and Environmental Monitoring for Brookhaven National Laboratory, 1947–1961. DOE Contract No. DE-AC02-98CH10866. Brookhaven National Laboratory, Upton, NY. May 2001.
- Nagle, C.M. 1975. Climatology of Brookhaven National Laboratory: 1949–1973. BNL-50466. Brookhaven National Laboratory, Upton, NY. November 1975.
- Nagle, C.M. 1978. Climatology of Brookhaven National Laboratory: 1974–1977. BNL-50857. Brookhaven National Laboratory, Upton, NY. May 1978.
- NYCRR. Title 27. Wild, Scenic, and Recreational River Systems Act. Article 15 and subsequent updates. New York State Department of Environmental Conservation, Albany, NY.
- Scorca, M.P., W.R. Dorsch, and D.E. Paquette. 1999. Stratigraphy and Hydrologic Conditions at the Brookhaven National Laboratory and Vicinity, Suffolk County, New York, 1994–97. U.S. Geological Survey Water Resources Investigations Report 99-4086. 55 pp.
- Warren, M.A., W. deLaguna, and N.J. Lusczynski. 1968. Hydrology of Brookhaven National Laboratory and Vicinity, Suffolk County, New York. U.S. Geological Survey Bulletin, 1156-C.

Intentionally Left Blank