Introduction

Brookhaven National Laboratory, a U.S. Department of Energy national laboratory, is world renowned for its leading-edge scientific research. In order to conduct this research in a safe and environmentally responsible manner, BNL has a comprehensive environmental protection program and is building a world class Environmental Management System. The Site Environmental Report is prepared annually by the Laboratory to summarize the status of environmental programs and performance. This report also describes any impacts that BNL research operations may have on the environment.

Brookhaven National Laboratory is located on 5,265 acres of pine barrens in Suffolk County in the center of Long Island, New York. In order to understand the Laboratory's environmental programs, activities, and impacts, it is important to know about its facilities, the ecosystem where it resides, and the human populations nearby. Chapter 1 discusses local site characteristics in terms of human population, geology, hydrology, climate, and ecological resources in order to place the following chapters in perspective.

1.1 PURPOSE OF THE 1999 SITE ENVIRONMENTAL REPORT

The U.S. Department of Energy (DOE) requires its facilities, including Brookhaven National Laboratory (BNL), to report on their environmental performance on an annual basis. The 1999 Site Environmental Report (SER) is prepared in accordance with DOE Order 231.1 (1995) and DOE Order 5400.1 (1988). The Site Environmental Report summarizes the programs, results, and status of BNL's environmental protection programs for calendar year 1999. The programs include environmental management, pollution prevention, and compliance assurance.

The SER also serves a larger function beyond complying with DOE requirements. BNL has been preparing SERs since 1968; consequently, these reports are a continuing record of the Laboratory's environmental activities and impacts. The SER serves as a tool to communicate information to staff, DOE, regulators, and the public. A condensed version of the SER, referred to as the Summary Report, is also available (see inside front cover for ordering information). The Summary Report, which clearly summarizes the technical content of the SER, is used to provide information to visitors, students, and members of the public in support of BNL's educational and community outreach programs.

1.2 THE MISSION AND HISTORY OF BROOKHAVEN NATIONAL LABORATORY

BNL is operated for DOE by Brookhaven Science Associates (BSA), a not-for-profit partnership of the 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 entered into an agreement with DOE under contract DE-AC02-98CH10886 and began operating the Laboratory on March 1, 1998. Prior to that, from 1947-1998, BNL was operated by Associated Universities Incorporated (AUI).

Approximately 3,000 resident scientists and operations 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 $400 million with about 88 percent of the funding coming from DOE. The remainder is from other domestic and international scientific and industrial clients. The majority of the Laboratory's budget directly supports the local economy. 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 the Island's economic health (Kamer 1995).

BNL's research initially focused on advanced physics, but it has since expanded into chemistry, materials science, biology, medicine, and environmental research. The Laboratory's large and unique scientific facilities make this research possible, providing the tools for BNL scientists and visiting researchers to extend the boundaries of knowledge and technology.

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, which support the DOE strategic missions, are to

- conceive, design, construct, and operate complex, leading-edge, user-oriented facilities in a safe and environmentally responsible manner that is responsive to the DOE and the needs of the international community of users;
- carry out basic and applied research in long-term programs at the frontier of science in support of DOE missions;
- develop advanced technologies that address national needs and to transfer them to other organizations and to the commercial sector; and
- 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 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.

The Laboratory's scientific history began in 1950 with the operation of the Brookhaven Graphite Research Reactor (BGRR), a research reactor used for peaceful scientific exploration in the fields of medicine, biology, chemistry, physics, and nuclear engineering. The BGRR

operated until 1969 and is now in the process of decommissioning. 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 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 (MRC) in 1958, the Brookhaven Medical Research Reactor (BMRR) in 1959, and the Brookhaven Linac Isotope Producer (BLIP) in 1973. Chemists and physicians teamed up to 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. These facilities are all currently operating.

High energy particle physics research 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 large accelerator, was built to surpass the Cosmotron's capabilities (see Figure 1-1). 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 is still operating. In 1982, the National Synchrotron Light Source (NSLS) began operation (see Figure 1-2). 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, is used to study the properties of matter.

Brookhaven's newest accelerator facility is the Relativistic Heavy Ion Collider (RHIC), which was completed in 1999 (see Figure 1-3). The RHIC is designed to recreate a state of matter that scientists believe existed moments after the universe was formed. RHIC is an

Figure 1-1. Alternating Gradient Synchrotron Facility. View inside the Alternating Gradient Synchrotron Facility, which produced three Nobel Prizes in Physics.

Figure 1-2. National Synchrotron Light Source. Scientists at the National Synchrotron Light Source study the properties of matter using charged particles and synchrotron light.

example of Brookhaven's commitment to fully integrate today's world class science with world class protection of the environment. This was exemplified when RHIC's operations received ISO 14001 Environmental Management System certification in August 1999 (see Chapter 2 for details).

Historical waste management practices at the Laboratory led to releases of chemicals and radioactive materials that resulted in soil and groundwater contamination. In 1989, BNL joined a number of Long Island sites when it was added to the federal Comprehensive Environmental Response, Compensation & Liability Act (CERCLA) National Priorities List, a listing of environmentally contaminated sites nationwide identified for priority cleanup (see Chapter 2 for details on the Laboratory's environmental restoration program progress).

This 1999 SER represents the first full calendar year of new site management. In November 1998, BNL issued a policy on integrating environmental stewardship into all facets of the Laboratory's mission and management of programs in a manner that protects the ecosystem and public health. Figure 1-4 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 environment. This SER describes BNL's progress and challenges in achieving its environmental stewardship goals. The problems that resulted from the Laboratory's first 50 years of operations cannot be fixed in one year, but BNL is now on the right path to continue its world class research in an environmentally responsible culture and in a clean and restored environment.

1.3 SITE LOCATION AND LOCAL POPULATION

BNL is located near the geographical center of Suffolk County, Long Island, about 60 miles east of New York City (Figure 1-5). About a third of the 1.37 million people that reside in Suffolk County live in Brookhaven Township where the Laboratory is situated (LIPA 1999). Figure 1-6 shows the distribution of the resident population on Long Island. As with all town-

Figure 1-3. Relativistic Heavy Ion Collider. RHIC received ISO 14001 certification for its Environmental Management System in 1999.

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 1-4. BNL's Environmental Stewardship Policy.

ships of Long Island, there has been an increase in residential housing in the Brookhaven Township in recent years, a trend that is expected to continue. Approximately eight thousand people live within 0.3 miles of the Laboratory's boundaries. Figure 1-7 shows the approximate resident population surrounding the site within a one-third mile radius, as well as the housing capacity for onsite residents and visitors.

More than 75 percent of BNL's 3,000 employees live within a 15-mile radius of the Laboratory (Figure 1-8). In addition, many of the 4,000 visiting scientists live onsite in dormitories, apartments, and guesthouses during their visit. Adding to the onsite staff and visiting scientists, BNL Public Affairs recorded over 27,000 local students and other members of the public visiting the Laboratory in 1999 to participate in educational and public outreach activities.

1.4 FACILITY AND OPERATIONS DESCRIPTION

Most of the principal facilities are located near the center of the BNL's 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, and fire breaks; and
- 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 (see section 1.7 of this chapter and Chapter 6 for more information).

The major scientific facilities are shown and briefly described in Figure 1-9. As noted earlier,

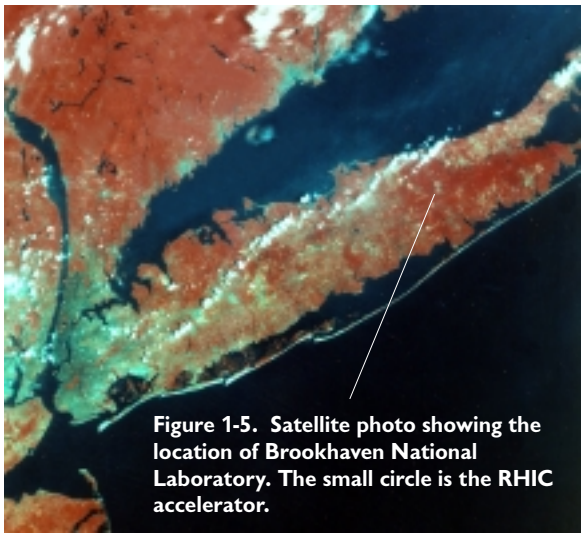

Figure 1-5. Satellite photo showing the location of Brookhaven National Laboratory. The small circle is the RHIC accelerator.

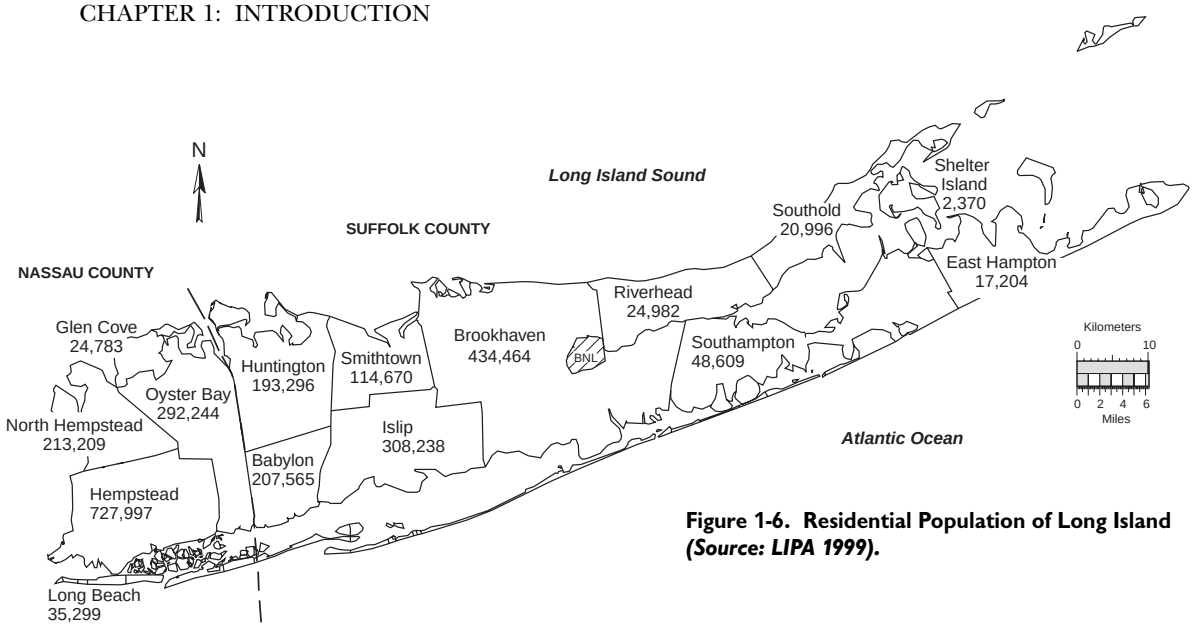

Figure 1-6. Residential Population of Long Island *(Source: LIPA 1999).*

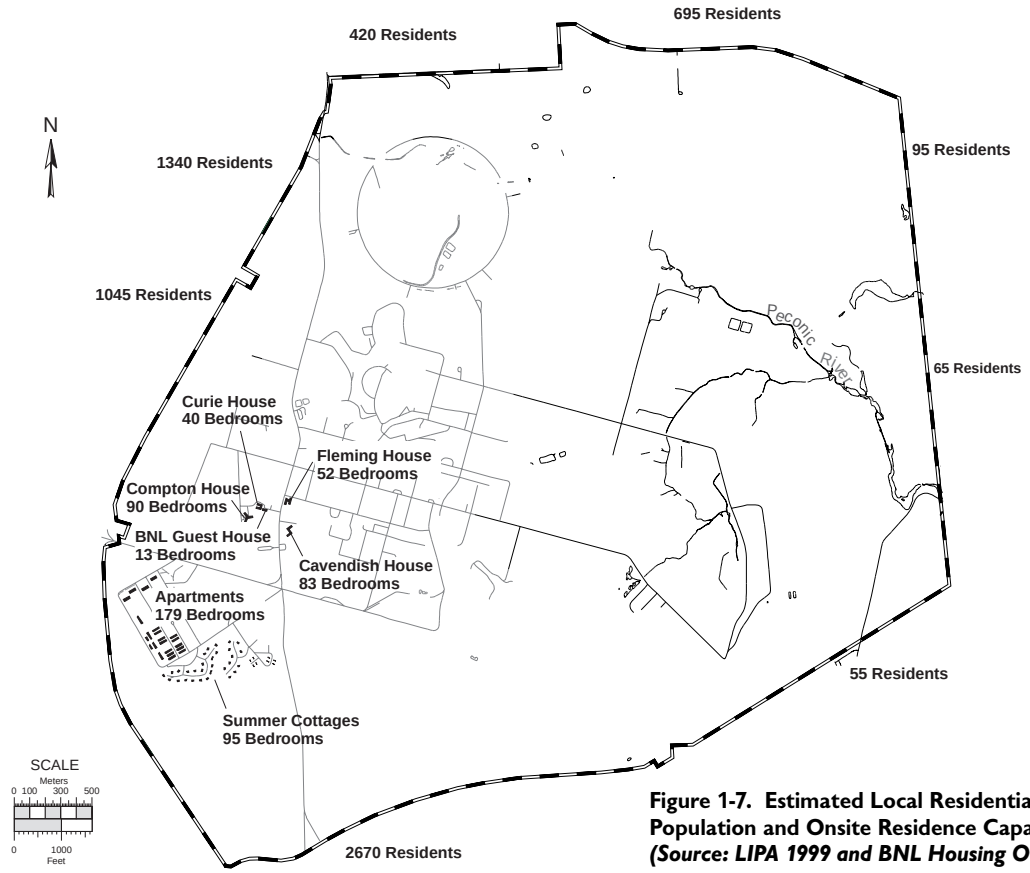

Figure 1-7. Estimated Local Residential Population and Onsite Residence Capacity *(Source: LIPA 1999 and BNL Housing Office).*

two major facilities, both reactors, are no longer operational at BNL: the BGRR and the HFBR. The BGRR was shut down in 1969 and is currently undergoing decommissioning. The HFBR ceased operation in 1997 and was permanently closed in 1999.

In addition to the scientific facilities, numerous other facilities support BNL's science and technology mission by providing basic utility and environmental services:

- *Water Treatment Plant.* The Water Treatment Plant is a potable water treatment facility with a capacity of 5 million gallons per day. Potable water is obtained from three 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, which reduces the necessity 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. Steam is conveyed to the user facilities through a network of underground piping. Condensate is collected and returned to the facility for reuse as a water and energy conservation measure.
- *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 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. The conversion reduced sulfur dioxide emissions by 95,000 pounds and nitrogen oxide emissions by 120,000 pounds per year.
- *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 3.0 million gallons 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 operation 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 and treating 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.

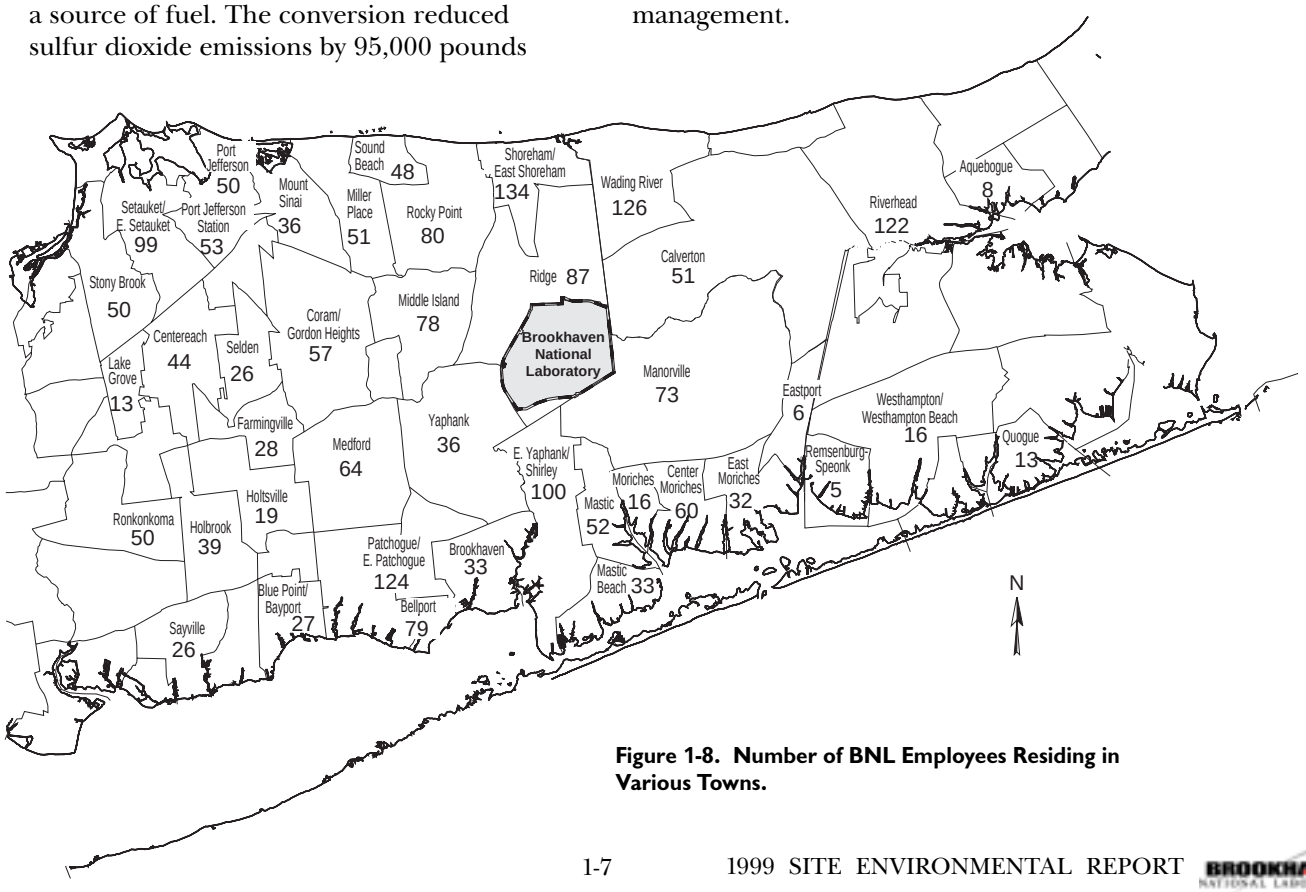

Figure 1-8. Number of BNL Employees Residing in Various Towns.

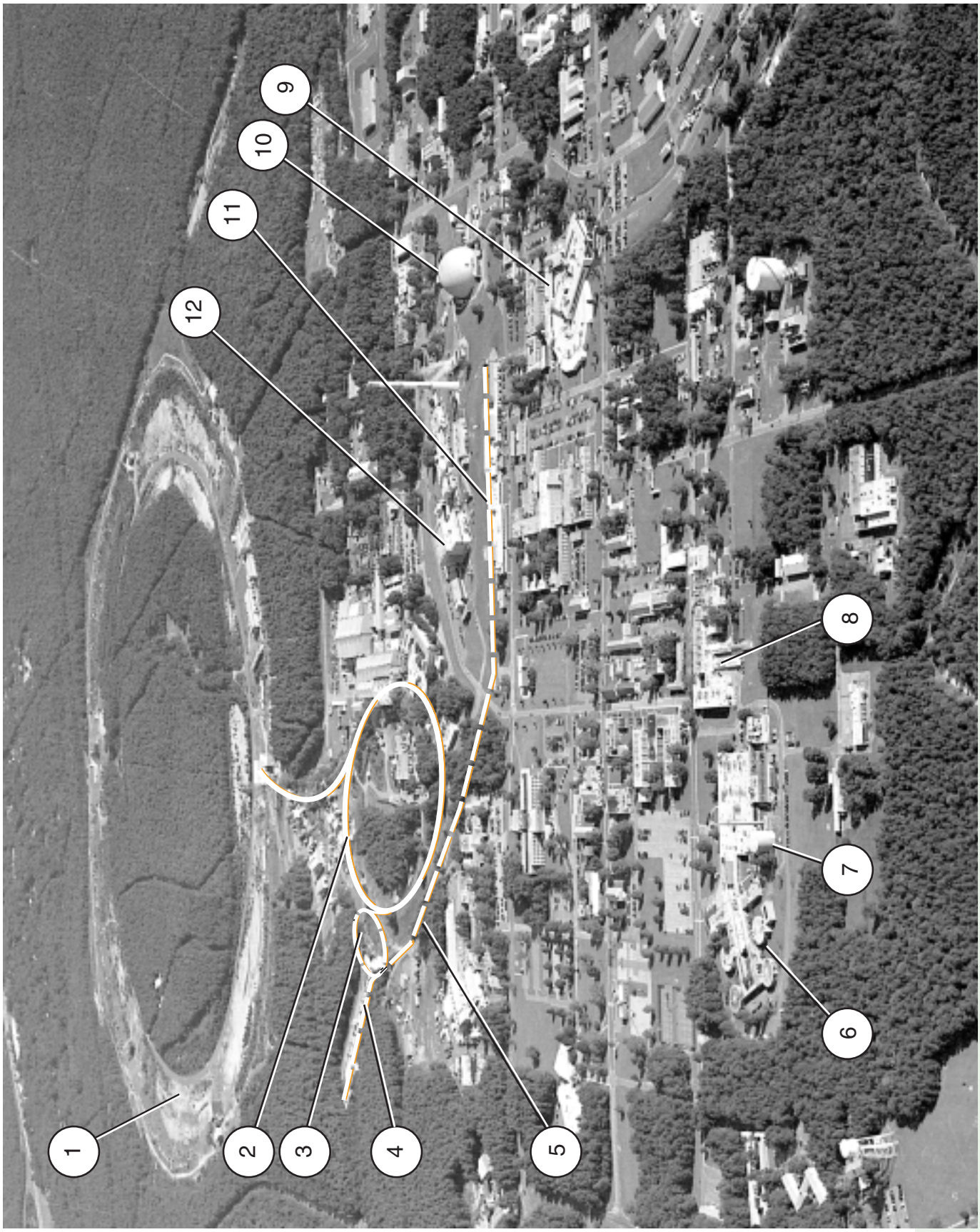
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Figure 1-9. Major Brookhaven Scientific Facilities.

1. RELATIVISTIC HEAVY ION COLLIDER (RHIC)

To be operating soon, 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 (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 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 makes beams of polarized protons for the AGS and, when it becomes operational, for the Relativistic Heavy Ion Collider (RHIC). 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 at 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 produces neutrons in an optimal energy range for experimental treatment of a type of brain cancer known as glioblastoma multiforme.

8. SCANNING TRANSMISSION ELECTRON MICROSCOPE (STEM)

This facility includes two microscopes, STEM 1 and STEM 3, used for biological research. Both powerful 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 for 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 closed 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 to research cancer therapy methods such as boron neutron capture therapy.

1.5 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 while 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 above sea level. Depth to groundwater from the surface of the land ranges from five feet near the Peconic River to about 80 feet in the higher elevation areas in the central and western portions of the site.

This groundwater system is a source of drinking water for both on and offsite private and public supply wells. Since it has a history of significant groundwater contamination from both BNL and non-BNL sources, EPA has classified this area as a "vulnerable groundwater system."

BNL uses approximately 2.6 million gallons per day of groundwater to meet potable water needs and heating and cooling requirements. Approximately 74 percent of the total water is returned to the aquifer through onsite recharge basins. About 19 percent is discharged into the Peconic River. Human consumption, evaporation (cooling tower and wind losses), and sewer line losses account for the remaining seven percent. An additional 0.6 million gallons per day of groundwater are pumped from remediation wells for treatment and then returned to the aquifer by the use of recharge basins.

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 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. This region and the water it contains is 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 per year) that varies seasonally.

The BNL site was also identified by the Long Island Regional Planning Board and Suffolk County as being part of a deep-flow recharge zone for Long Island groundwater (Koppelman 1978, SCDHS 1987). This finding indicates that precipitation and surface water that recharge within this zone have the potential to replenish the deep 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). In general, these deeper aquifers discharge to the Atlantic Ocean or to the Long Island Sound.

Groundwater flow direction across the BNL site is influenced by natural drainage systems moving eastward along the Peconic River, southeast towards the Forge River and south toward the Carmans River. This causes the flow direction of the groundwater to vary significantly and frequently in the industrial areas onsite. Two natural groundwater divides have been identified near the BNL site (Scorca *et al.* 1999). One is located approximately 0.5 mile north of BNL and a second transects portions of the site when the water table is high (i.e., when the aquifer flows into the stream bed). These 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 (Geraghty and Miller 1996). In general terms, it takes approximately 20 to 22 years for groundwater to travel from the central, developed area of the site to the BNL southern boundary.

See Chapter 7 for details on BNL's comprehensive groundwater protection and management program.

1.6 CLIMATIC DATA

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 1999 annual wind rose for BNL, which depicts the annual frequency distribution of wind speed and direction, measured on an onsite meteorological tower at heights of 30 and 300 feet.

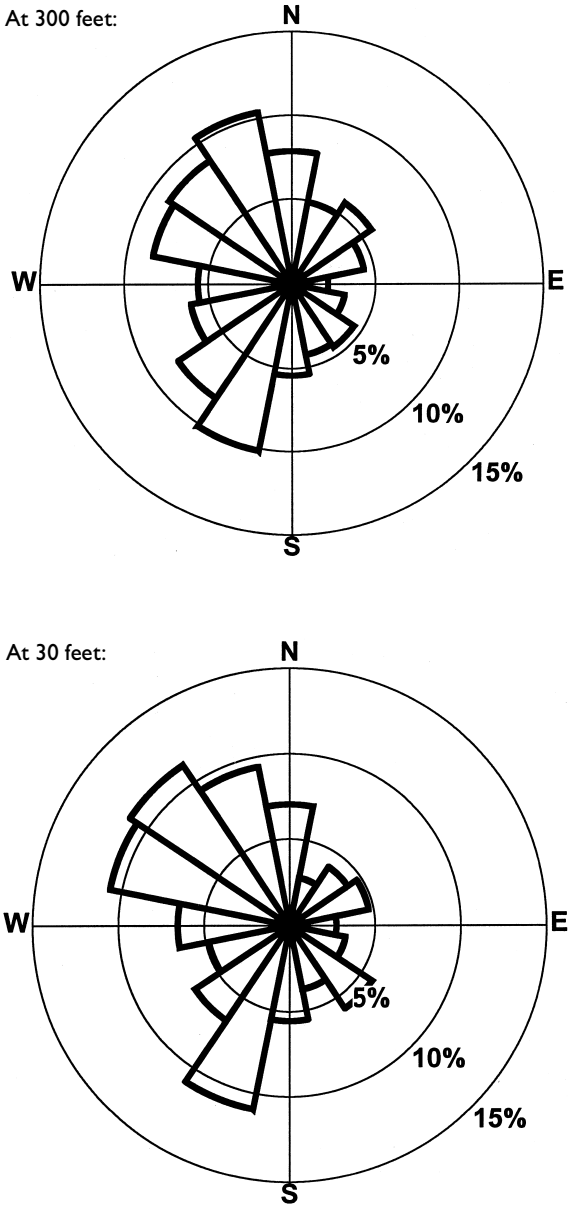
The total precipitation for 1999 was 51.72 inches. Most of the precipitation was received from January through March and August through October, with a very dry spring and early summer. Precipitation in 1999 was 3.26 inches above the 50-year annual average. Figures 1-11 and 1-12 present the 1999 monthly and the 50-year annual precipitation data, respectively.

The monthly mean temperature in 1999 was 52.7°F, ranging from a monthly mean low temperature of 32.2°F in January to a monthly mean high temperature of 76.3°F in July. The average annual mean temperature for 1999 was 2.8°F above the 50-year annual average, continuing a trend of increasing annual temperatures. In general, using a linear average, temperatures at BNL have increased 1.86°F over the last 50 years, compared to a worldwide average surface temperature increase of 0.5-0.6°F (Jones *et al.* 1999). Figures 1-13 and 1-14 show the 1999 temperatures and the historical annual mean temperatures, respectively.

1.7 ECOLOGICAL RESOURCES

BNL is located in the oak/chestnut forest region of the Coastal Plain. BNL property constitutes five percent of the 100,000-acre pine barrens of Long Island. 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 major 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. The past disturbances with the most impact were land clearing (the land was cleared extensively when the site was Camp Upton), fire, local flooding, and draining. Part of the Peconic River running through BNL's property was designated "scenic" in accordance with the New York State's Wild, Scenic, and Recreational River System Act (New York State 1972).

Over 230 plant species have been identified onsite. The fifteen mammal species endemic to the site include species common to mixed hardwood forests and open grassland habitats. The white-tailed deer density is at least 100 per



Explanation: The arrows formed by the wedges indicate wind direction. Each concentric circle represents a 5% frequency. The wind direction was measured at heights of 30 feet and 300 feet. For example, this diagram indicates that the predominant wind direction at 30 feet in 1999 was from the northwest.

Figure 1-10. Annual Wind Rose for 1999.

square mile (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 ten reptile species have been identified. Ecological studies at the BNL site have confirmed thirteen breed-

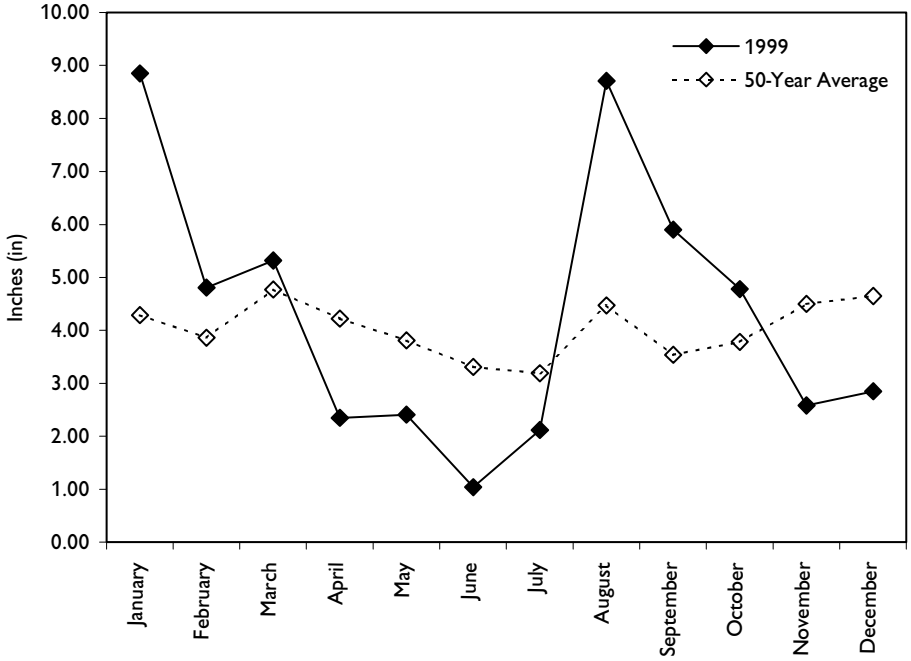


Figure 1-11. 1999 Monthly Precipitation versus 50-Year Monthly Average.

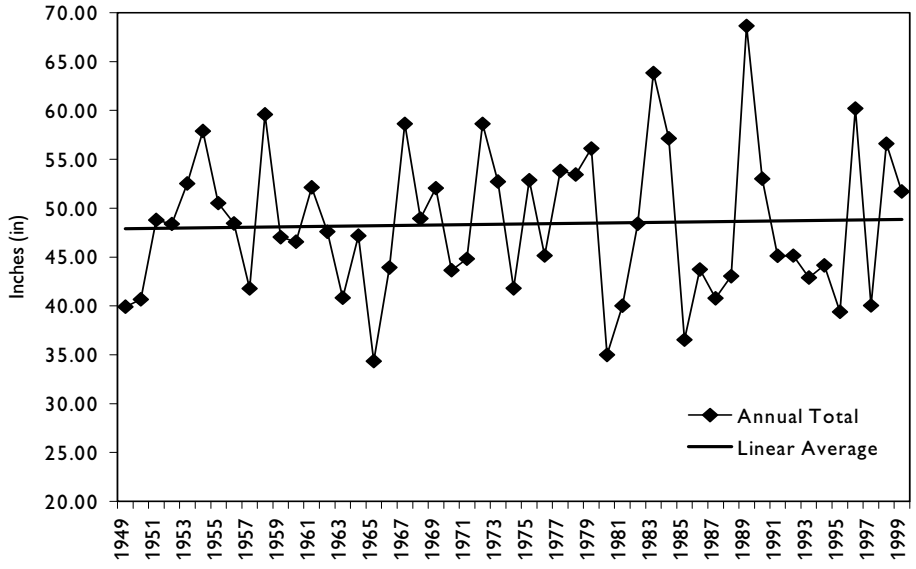


Figure 1-12 Fifty-Year Annual Precipitation Trend.

ing sites for the New York State endangered eastern tiger salamander (*Ambystoma tigrinum*) in BNL's vernal pools and some recharge basins. Nine species of fish have also been identified at BNL. The banded sunfish (*Eanneacanthus obesus*) was listed as a state threatened species in 1999 by the New York State Department of Environmental Conservation. It lives solely within the Peconic River system, including the portion of the river onsite (Scheibel 1990). 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.

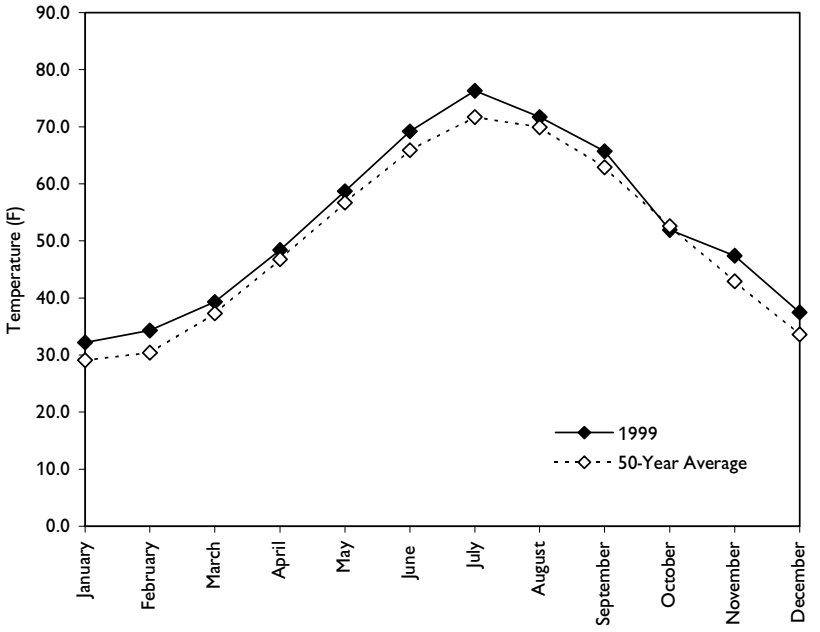


Figure 1-13. 1999 Monthly Mean Temperature versus 50-Year Monthly Average.

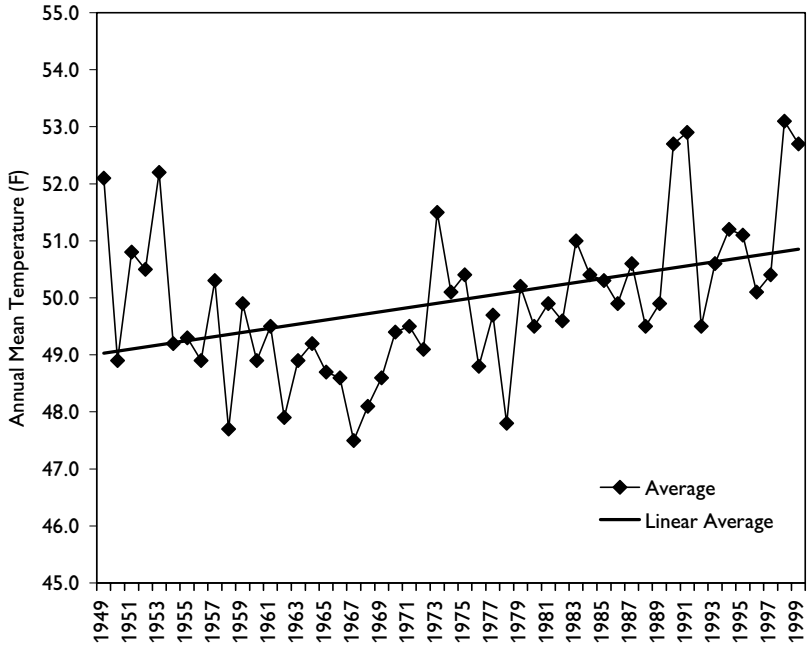


Figure 1-14. Fifty-Year Annual Mean Temperature Trend.

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