

2020

SITE ENVIRONMENTAL REPORT

BROOKHAVEN NATIONAL LABORATORY

Volume I

October 2021

Prepared by
Brookhaven Science Associates, LLC
For the U.S. Department of Energy
Under Contract No. DE-SC0012704

Brookhaven National Laboratory
Brookhaven Science Associates, LLC
P.O. Box 5000
Upton, NY 11973-5000

EXPLORING EARTH'S MYSTERIES
...PROTECTING ITS FUTURE

The text of this book has been copied on 100% post-consumer recycled paper, a move that saves approximately 20 trees compared to using its virgin equivalent.



PRINTED ON RECYCLED PAPER

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe on privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency, contractor, or subcontractor thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency, contractor, or subcontractor thereof.

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

Executive Summary

Brookhaven National Laboratory (BNL) is managed on behalf of the Department of Energy (DOE) by Brookhaven Science Associates (BSA), a partnership between the Research Foundation for the State University of New York on behalf of Stony Brook University and Battelle. For over 70 years, the Laboratory has played a lead role in the DOE Science and Technology mission and continues to contribute to the DOE's missions in energy resources, environmental quality, and national security. BNL manages its world-class scientific research with particular sensitivity to environmental issues and community concerns. The Laboratory's Environmental, Safety, Security, and Health (ESSH) Policy reflects the commitment of BNL's management to fully integrate environmental stewardship into all facets of its mission and operations.

BNL prepares an annual Site Environmental Report (SER) in accordance with DOE Order 231.1B, Environment, Safety, and Health Reporting. The report is written to inform the public, regulators, employees, and other stakeholders of the Laboratory's environmental performance during the calendar year in review. Volume I of the SER summarizes environmental data; environmental management performance; compliance with applicable DOE, federal, state, and local regulations; and performance in restoration and surveillance monitoring programs. BNL has prepared annual SERs since 1971 and has documented nearly all its environmental history since the Laboratory's inception in 1947.

Volume II of the SER, the Groundwater Status Report, is also prepared annually to report on the status of groundwater protection and restoration efforts. Volume II includes detailed technical summaries of groundwater data and treatment system operations and is intended for regulators and other technically oriented stakeholders. A summary of the information contained in Volume II is included in Chapter 7, Groundwater Protection, of this volume.

Both reports are available in print and as downloadable files on the BNL web page at [https:// www. bnl.gov/ esh/env/ser/](https://www.bnl.gov/esh/env/ser/).

As described in the Inside Cover of this year's report, calendar year 2020 witnessed extraordinary circumstances created by the COVID-19 pandemic. This Executive Summary highlights some of the pandemic's impacts on Laboratory usage of natural resources, as well as environmental compliance and regulatory activities. These topics are explored in further detail throughout the chapters.

ENVIRONMENTAL MANAGEMENT SYSTEM

The Laboratory's Integrated Safety Management System (ISMS) incorporates management of environment (i.e., environmental protection and pollution prevention), safety, and health (ES&H) issues into all work planning. BNL's ISMS ensures that the Laboratory integrates DOE's five Core Functions and seven Guiding Principles into all work processes. These processes contributed to

BNL's achievement of registration under the International Organization for Standardization (ISO) 14001 Standard for the Laboratory's Environmental Management System (EMS). This standard requires an organization to develop a policy, create plans to implement the policy, implement the plans, check progress and take correction actions, and review the system periodically to ensure its continuing suitability, adequacy, and effectiveness.

An EMS was fully established at BNL in 2001 to ensure that environmental issues are systematically identified, controlled, and monitored. The EMS also provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual environmental improvement. The cornerstone of the Laboratory's EMS is the ESSH Policy. The policy makes clear the Laboratory's commitment to environmental stewardship, the safety and health of its employees, and the security of the site. Specific environmental commitments in the policy include compliance, pollution prevention, conservation, community outreach, and continual improvement. The policy is posted throughout the Laboratory and on the BNL website. It is also included in all training programs for new employees, guests, and contractors.

The Laboratory's EMS was designed to meet the rigorous requirements of the globally recognized ISO 14001 Environmental Management Standard. BNL was the first DOE Office of Science Laboratory to become officially registered to this standard. BNL's external certification organization, ERM Certification Verification Services, conducted an external surveillance audit of BNL's conformance to the ISO 14001 Standard in July 2020. The Surveillance identified no nonconformances and determined that the Laboratory was in full conformance to the Standard; therefore, BNL will maintain its current certification.

BNL follows Executive Order (EO) 13834, Efficient Federal Operations, which replaced EO 13693, Planning for Federal Sustainability in the Next Decade, in 2018. The order establishes sustainability goals for federal agencies with a focus on sustainability initiatives that save money and increase efficiency across the government with guidance, recommendations, plans, and numerical targets. DOE Order 436.1, Departmental Sustainability, provides requirements and responsibilities for managing sustainability within DOE to ensure facilities are working towards sustainability goals established in its Strategic Sustainability Performance Plan (SSPP) pursuant to EO 13834. Each DOE facility is required to have a Site Sustainability Plan (SSP) in place detailing the strategy for achieving these long-term goals and due dates and to provide an annual status. The

requirements influence the future of the Laboratory's EMS program and have been incorporated into BNL's SSP. For a status summary of BNL's 2020 SSP, see Appendix E.

The Laboratory's Pollution Prevention (P2) Program is an essential element for the successful implementation of BNL's EMS. The P2 Program reflects the national and DOE pollution prevention goals and policies and represents an ongoing effort to make pollution prevention and waste minimization an integral part of the Laboratory's operating philosophy.

Pollution prevention and waste reduction goals have been incorporated as performance measures into the DOE contract with BSA and BNL's ESSH Policy. The overall goal of the P2 Program is to create a systems approach that integrates pollution prevention and waste minimization, resource conservation, recycling, and affirmative procurement into all planning and decision making. The implementation of pollution prevention opportunities, recycling programs, and conservation initiatives continues to reduce both waste volumes and management costs.

In 2020, the P2 Program resulted in nearly \$1.7 million in cost avoidance or savings and resulted in the reduction or reuse of approximately 0.9 million pounds of waste. Reduced revenue and volume of recyclables compared to previous years are a direct impact of limited operational status caused by the COVID-19 pandemic. The P2 Program funded 15 new proposals, investing approximately \$21,500. The proposals involved reducing risk, promoting use of bio-friendly alternative products, improving small energy efficiency projects or reducing water, and promoting overall environmentally sustainable business practices.

The baseline recycling rate goal for federal facilities is 50 percent. BNL's annual average recycling rate consistently outperforms the baseline. The 2020 annual recycling rate was 63 percent.

As a testament to its strong environmental program, the Lab received the Green Electronics Council's Electronic Product Environmental Assessment Tool Gold Award, the DOE's GreenBuy Award, and a second GreenBuy Prime Award.

BNL continues to decrease its energy consumption and increase savings. In each of the past ten years, the water consumption total was

approximately half the 1999 total—a reduction of nearly a half billion gallons per year. In 2020, natural gas was used to meet over 99 percent of the heating and cooling needs of the Laboratory's major facilities, further reducing greenhouse gas (GHG) emissions. Additional information on natural gas and fuel oil use can be found in Chapter 4.

The Laboratory also scheduled operations at the Relativistic Heavy Ion Collider to avoid peak demand periods. This reduced the electric demand by approximately 25 megawatts, saving approximately \$1.4 million in electric demand costs.

In 2020, BNL maintained its contract with the New York Power Authority, resulting in an overall cost avoidance of \$29.1 million.

In addition, the 2020 output from the Lab's Long Island Solar Farm (LISF) was 48 million kWh and resulted in an avoidance of approximately 26,000 tons of carbon.

Chapter 2 of this report further describes these and other sustainability efforts, as well as implementation of BNL's EMS and P2 Program, in more detail.

BNL'S ENVIRONMENTAL MANAGEMENT PROGRAM

BNL's Environmental Management Program consists of several Laboratory-wide and facility-specific environmental monitoring and surveillance programs. These programs identify potential pathways of public and environmental exposure and evaluate the impacts BNL activities may have on the environment. An overview of the Laboratory's environmental programs and a summary of performance for 2020 are provided below.

COMPLIANCE MONITORING PROGRAM

BNL has an extensive program in place to ensure compliance with all applicable regulatory and permit requirements. The Laboratory must comply with more than 100 sets of federal, state, and local environmental regulations; numerous site-specific permits; ten equivalency permits for the operation of groundwater remediation systems; and several other binding agreements.

In 2020, the Laboratory operated in compliance with most of the requirements; any instance of noncompliance was reported to regulatory agencies and corrected expeditiously, or a plan was

put in place to come into compliance. Emissions of nitrogen oxides, carbon monoxide, and sulfur dioxide from the Central Steam Facility (CSF) were well within permit limits in 2020.

Recorded excess opacity measurements from CSF boilers were investigated and documented in quarterly Site-Wide Air Emissions and Monitoring Systems Performance Reports submitted to the New York State Department of Environmental Conservation (NYSDEC).

There were no discharges of Halon 1211 from portable fire extinguishers or Halon 1301 from accidental or fire-induced activation of fixed fire suppression systems in 2020. Portable Halon fire extinguishers continue to be removed and replaced by dry-chemical or clean agent units as part of an ongoing program to phase out the use of chlorofluorocarbons as extinguishing agents to eliminate possible ozone-depleting substance emissions.

With the exception of a lead action level exceedance in August, BNL's drinking water and the supply and distribution system were in compliance with all applicable county, state, and federal regulations regarding drinking water quality, monitoring, operations, and reporting in 2020. Most of the liquid effluents discharged to surface water and groundwater also met applicable New York State Pollutant Discharge Elimination System (SPDES) permit requirements.

An investigation into the cause(s) of tolyltriazole (TTA) exceedances at the Sewage Treatment Plant (STP) and associated corrective actions continued throughout 2020. BNL staff continue to work closely with the DOE and NYSDEC to identify possible solutions.

In 2020, groundwater monitoring at the Laboratory's Major Petroleum Facility (MPF) and Waste Management Facility (WMF) demonstrated that current operations are not affecting groundwater quality.

As part of the ongoing CERCLA program, BNL continued the surveillance and maintenance of the Brookhaven Graphite Research Reactor (BGRR) and the HFBR. The exterior coating abatement of the HFBR stack was completed and demolition of the stack was initiated in December. Due to contractor mobilization delays related to COVID-19, DOE submitted a milestone extension request to the EPA and NYSDEC in August 2020 to extend the administrative closeout until July 2021.

Efforts to implement release prevention measures and minimize impacts of spills of materials continued in 2020. There were 14 spills in 2020 and four of those spills met regulatory agency reporting criteria. All spills were immediately cleaned up and waste was properly disposed.

Hazardous waste from routine operations decreased during 2020, mostly due to the Lab's limited operational status related to COVID-19. There was also a significant reduction in non-routine waste generation during 2020 due to the Lab's limited operational status. No major construction or demolition projects occurred during 2020.

In 2020, due to the pandemic, inspections by federal, state, or local regulators were limited. BNL was inspected on seven occasions. These inspections included STP operations, hazardous waste management facilities, and the potable water system. Immediate corrective actions were taken to address all compliance issues raised during these inspections.

The DOE Brookhaven Site Office (BHSO) continued to provide oversight of BNL programs during 2020 and participated as an observer of BSA's Multi-Topic Assessment of BNL's environmental protection programs. BHSO participation comprised of observing BSA's scoping, assessment conduct, and reporting.

Despite the COVID-19 pandemic, BNL proactively communicated with its internal and external stakeholders through virtual platforms during 2020. Monthly interagency calls were held, and the Summer Sunday series was held virtually. Additionally, all regularly scheduled Community Advisory Council and Brookhaven Executive Roundtable meetings were held virtually to ensure continued and timely communication with the community.

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

AIR QUALITY PROGRAM

BNL monitors radioactive emissions at three facilities to ensure compliance with the requirements of the Clean Air Act. Environmental Protection Agency (EPA) regulations require continuous monitoring of all sources that have the potential to deliver an annual radiation dose greater than 0.1 mrem to a member of the public; all other facilities capable of delivering any radiation dose

require periodic confirmatory sampling.

BNL has two active facilities: the Brookhaven Linac Isotope Producer (BLIP), whose emissions are continuously monitored with an inline detection system, and the Target Processing Laboratory (TPL), which has a particulate filter sampling system to continuously collect samples for gross alpha and gross beta activity, and one inactive facility, the High Flux Beam Reactor (HFBR), where periodic emissions monitoring is conducted.

During 2020, BNL facilities released a total of 0.242 Curies of tritium. Because the Lab used natural gas to meet 99 percent of its heating and cooling needs in 2020, emissions of particulates, oxides of nitrogen, sulfur dioxide, and volatile organic compounds were well below the respective regulatory permit criteria pollutant limits.

In 2020, the LISF, a large array of more than 164,000 solar photovoltaic panels constructed on the BNL site, provided 48 million kilowatt-hours of solar energy to Long Island. This equates to 25,988 metric tons CO₂ equivalents (MT CO₂e) GHG offset or reduction. BNL consumed 116,430 megawatts of hydropower, providing a net combined GHG reduction of 39,117 MT CO₂e from the LISF and hydropower.

The COVID-19 pandemic had significant impacts on air travel GHG emissions. Air travel GHG emissions dropped 4,756 MT CO₂e, a 66 percent decrease from fiscal year 2019, while employee GHG emissions decreased by 1,267 MT CO₂e, a 33 percent drop from fiscal year 2019. These transportation GHG emission reductions were due to the Laboratory's implementation of its limited operations plan (consistent with New York State and DOE guidelines) from March 23 to September 30, 2020.

Chapter 4 of this report describes BNL's Air Quality Program, monitoring data, and other GHG reducing efforts in further detail.

WATER QUALITY SURVEILLANCE PROGRAM

Wastewater generated from BNL operations is treated at the STP before it is discharged to nearby groundwater recharge basins. Some wastewater may contain very low levels of radiological, organic, or inorganic contaminants. Monitoring, pollution prevention, and vigilant operation of

treatment facilities ensure that these discharges comply with all applicable regulatory requirements and that the public, employees, and the environment are protected.

Analytical data for 2020 shows that the average gross alpha and beta activity levels in the STP discharge (EA, Outfall 001) were within the typical range of historical levels and well below New York State Drinking Water Standards (NYS DWS). Tritium was detected once above method detection limits (MDL) in the STP discharge in January 2020. No cesium-137, strontium-90, or other gamma-emitting nuclides attributable to Laboratory operations were detected. Non-radiological monitoring of the STP effluent showed that, with the exception of tolyltriazole exceedances, organic and inorganic parameters were within SPDES effluent limits or other applicable standards.

Stormwater and cooling water discharges to recharge basins are sampled throughout the year and analyzed for gross alpha and beta activity, gamma-emitting radionuclides, and tritium. Each recharge basin is a permitted point-source discharge under the Laboratory's SPDES permit. In 2020, the average concentrations of gross alpha and beta activity in stormwater and cooling water discharged to recharge basins were within typical ranges and no gamma-emitting radionuclides were detected.

Disinfection byproducts continue to be detected at low concentrations above the MDL in discharges to recharge basins due to the use of chlorine and bromine for the control of algae and bacteria in potable and cooling water systems. Inorganics (i.e., metals) were detected; however, their presence is due primarily to sediment runoff in stormwater discharges.

The Peconic River did not flow offsite in 2020. Radiological data from Peconic River surface water sampling show that the average concentrations of gross alpha and gross beta activity from on-site locations were indistinguishable from control locations, and all detected levels were below the applicable NYS DWS. No gamma-emitting radionuclides attributable to Laboratory operations were detected either upstream or downstream of the former STP outfall, and tritium was not detected above MDL's in any of the surface water samples.

Chapter 5 of this report describes BNL's Water Quality Surveillance Program and monitoring data in further detail.

NATURAL AND CULTURAL RESOURCE MANAGEMENT PROGRAM

The BNL Natural Resource Management Program was designed to promote stewardship of the natural resources found on site and to integrate natural resource management and protection with the Laboratory's scientific mission. The program includes protecting and monitoring the ecosystem on site, conducting research, and communicating the results with the public, stakeholders, and staff members.

BNL conducts routine monitoring of flora and fauna to assess the impact, if any, of past and present activities on the Laboratory's natural resources. In 2020, deer, vegetation, and soil sampling results were consistent with previous years' results.

In cooperation with NYSDEC, habitat surveys have been routinely conducted since 1999. In 2020, surveys were not completed due to time constraints and impacts from COVID-19.

To control the goose population, the Laboratory manages nesting through egg oiling under an annual permit from the U.S. Fish & Wildlife Service. In 2020, the nest management program was suspended due to restrictions associated with COVID-19.

High deer populations are a regional problem, and the Laboratory is just one area on Long Island with such an issue. The removal of 82 deer effectively brought the population to approximately 275 animals. With reproduction at approximately 55 percent, the population at the end of 2020 was estimated at approximately 425 deer. Efforts were underway in December 2020 to plan for the next round of population management in 2021.

Deer-related collisions on site decreased in 2020 compared to 2019, an indication of decreased population from the 2020 deer harvest as well as fewer employees onsite due to the COVID-19 pandemic.

In January 2020, the DOE announced the award for construction of the Electron-Ion Collider at BNL. This resulted in the development of an Environmental Evaluation and Notification Form that was submitted to the BHSO and a determination was issued that an Environmental

Assessment (EA) would be necessary. The EA was developed and presented to the Community Advisory Council in September 2020 and was further developed for submission to New York State by year's end.

The Laboratory sponsors a variety of educational and outreach activities involving natural resources. These programs are designed to help participants understand the ecosystem and to foster interest in science. Wildlife programs are usually conducted at BNL in collaboration with local agencies, colleges, and high schools. Ecological research is also conducted on site to update the current natural resource inventory, gain a better understanding of the ecosystem, and guide management planning.

In 2020, due to COVID-19 restrictions, Lab internships were required to be conducted virtually. However, the Environmental Protection Division was able to host one intern who focused on developing photo recognition software as part of the 4-Poster™ tick management project.

The Lab continued its collaboration with the State University of New York's School of Environmental Science and Forestry allowing for greater levels of research within the Central Pine Barrens and Upton Reserve. The collaboration continued a forest health monitoring program that began in 2019.

The Laboratory manages its cultural resources under requirements of the National Historic Preservation Act. In 2020, additional buildings over 50-years of age were evaluated and nineteen were determined to be eligible for the National Register of Historic Places.

Chapter 6 of this report describes BNL's natural and cultural resources in further detail.

GROUNDWATER PROTECTION MANAGEMENT PROGRAM

BNL has made significant investments in environmental protection programs over the past 25 years and continues to make progress in achieving its goal of preventing new groundwater impacts and remediating previously contaminated groundwater. The Laboratory's extensive groundwater monitoring well network is used to evaluate progress in restoring groundwater quality, comply with regulatory permit requirements, and monitor active research and support facilities where there

is a potential for environmental impact.

Due to the detection of Per and Polyfluoroalkyl Substances (PFAS) in water samples collected from three BNL water supply wells in 2017, BNL conducted a search of available records to determine a source of PFAS. In 2018, BNL identified eight areas where firefighting foam containing PFAS had been used for firefighter training or fire suppression system maintenance from 1966 until 2008. Groundwater characterization confirmed the presence of PFAS in each of the eight areas, with the highest concentrations detected at the location of the BNL's former firehouse (1947-1985) and at the current firehouse (1986-present). The Laboratory continues its efforts to prevent new groundwater impacts and is vigilant in measuring and communicating its performance.

During 2020, BNL collected groundwater samples for PFAS and 1,4-dioxane analyses from approximately 360 on-site and off-site monitoring wells, as well as conducted a detailed characterization of the PFAS plumes associated with the current and former firehouse facilities to support the design of two groundwater treatment systems. The results for these samples are summarized in the 2020 Groundwater Status Report (BNL 2021).

Groundwater quality at BNL is routinely monitored through a network of on- and off-site wells. In addition to water quality assessments, water levels are routinely measured in monitoring wells annually to assess variations in the direction and velocity of groundwater flow.

During 2020, BNL collected groundwater samples from 802 permanent monitoring wells and 102 temporary wells during 1,816 individual sampling events. Groundwater elevations were measured in 160 monitoring wells for mapping purposes. Seven groundwater remediation systems removed 44 pounds of volatile organic compounds and returned approximately 823 million gallons of treated water to the Upper Glacial aquifer. Also, one groundwater treatment system removed approximately 0.4 millicurie of strontium-90 (Sr-90) while remediating approximately 16 million gallons of groundwater.

Since 2003, BNL has removed approximately 34 millicuries of Sr-90 from the groundwater while remediating 260 million gallons of groundwater.

As a result of the successful operation of these treatment systems, significant reductions in contaminant concentrations have occurred in several on- and offsite areas.

Chapter 7 of this report provides an overview of this program, and the SER Volume II, Groundwater Status Report, provides detailed descriptions, data, and maps relating to all groundwater monitoring and remediation performed in 2020.

RADIOLOGICAL DOSE ASSESSMENT PROGRAM

The Laboratory routinely reviews its operations to ensure that any potential radiological dose to members of the public, workers, and the environment is “As Low As Reasonably Achievable” (ALARA). The potential radiological dose to members of the public is calculated at an off-site location closest to an emission source as the maximum dose that could be received by an off-site individual, defined as the “maximally exposed off-site individual” (MEOSI). The dose to the MEOSI is the sum total from direct and indirect dose pathways via air immersion, inhalation of particulates and gases, and ingestion of local fish and deer meat.

In 2020, the total effective dose (TED) to the MEOSI of 0.913 mrem (9.13 μ Sv) from Laboratory operations was well below the dose limit of 100 mrem in a year required by DOE Order 458.1, as well as all other EPA and DOE regulatory dose limits for the public, workers, and the environment.

Dose to the maximally exposed individual (MEI) on site and outside of controlled areas, calculated from thermo-luminescent dosimeter monitoring records, was 27 mrem above natural background radiation levels, also well below the 100-mrem DOE limit on dose.

Based on a five-year analysis of measurement data for ambient radiation dose, the ambient dose decreased slightly in 2020 as readiness reviews took place in preparation for ramping up production testing for that same process. Dose to aquatic and terrestrial biota were also evaluated and found to be well below DOE regulatory limits. In summary, the overall dose impact from all Laboratory activities in 2020 was comparable to that of natural background radiation levels.

Chapter 8 of this report describes the BNL Radiological Dose Assessment Program and monitoring data in further detail.

QUALITY ASSURANCE PROGRAM

The multilayered components of the BNL Quality Assurance (QA) Program ensure that all analytical data reported in this report are reliable and of high quality and meet quality assurance and quality control objectives. Samples are collected and analyzed in accordance with EPA methods and BNL standard operating procedures that are designed to ensure samples are representative and the resulting data are reliable and defensible.

Quality control in the analytical laboratories is maintained through daily instrument calibrations, efficiency and background checks, and testing for precision and accuracy. Data are verified and validated as required by projectspecific quality objectives before being used to support decision making.

In 2020, environmental samples were analyzed by five contract analytical laboratories. All samples were analyzed according to EPA-approved methods or by standard industry methods where no EPA methods are available. In addition, field sampling technicians performed field monitoring for parameters such as conductivity, dissolved oxygen, pH, temperature, and turbidity. In 2020, procedures for calibrating instruments, analyzing samples, and assessing QC were consistent with EPA methodology.

The data validations, data verifications, and Data Quality Objective checks conducted on analytical results at BNL were designed to eliminate any data that fails to meet the DQO of each project. The results of the independent performance evaluation assessments and assessments of contractor laboratories summarized in this report were used to assess the quality of the results. Therefore, the data used in this Site Environmental Report are of acceptable quality.

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

Intentionally Left Blank

2020 SITE ENVIRONMENTAL REPORT

The SER Team thanks the many Lab employees who contributed to and assisted with this report.



The SER Team

*(Back row, left to right) Jennifer Higbie, Timothy Green, Douglas Paquette, Jason Remien, and William Dorsch.
(Front row, left to right) Larry Singh, Robert Howe, Jeffrey Williams, Amber Aponte, and Timothy Welty
(not pictured: Deborah Bauer).*



The Environmental Protection Division Field Sampling Team

(From left to right) James Milligan, Robert Metz, Richard Lagattolla, AJ Scheff, and Melissa Yost.

Intentionally Left Blank

Acknowledgments

The production of the BNL 2020 Site Environmental Report (SER), Volume I, required the knowledge, skill, experience, and cooperation of many people and organizations at the Laboratory. The lead authors, co-authors, and other contributing staff involved in producing the report are listed below.

LEAD CHAPTER AUTHORS

ENVIRONMENTAL PROTECTION DIVISION

EXECUTIVE SUMMARY Amber Aponte
CHAPTER 1 Amber Aponte
CHAPTER 2 Deborah Bauer
CHAPTER 3 Jason Remien
CHAPTER 4 Jeffrey Williams

CHAPTER 5 Timothy Green
CHAPTER 6 Timothy Green
CHAPTER 7 William Dorsch/Douglas Paquette
CHAPTER 8 Tim Welty
CHAPTER 9 Larry Singh

CO-AUTHORS AND/OR KEY CONTRIBUTORS

ENVIRONMENTAL PROTECTION DIVISION

Jennifer Higbie
Robert Howe
Richard Lagattolla
Robert Metz
James Milligan
AJ Scheff
Glen Todzia
Melissa Yost

STAKEHOLDER & COMMUNITY RELATIONS

Amy Engel

FACILITIES AND OPERATIONS

Mark Toscano

RADIOLOGICAL CONTROL DIVISION

Charles Rose, Jr.
Nate Foster

SER PROJECT COORDINATOR

Amber Aponte, Environmental Protection Division

GRAPHIC DESIGNER

Lisa Jansson, Stakeholder & Community Relations

PHOTOGRAPHER

Joe Rubino, Stakeholder & Community Relations

“Thank you” to the staff and management of the following organizations who assisted the authors in the preparation of this report by providing technical peer reviews, sample and data collection, maps and diagrams, and other support necessary to make this report possible.

Stakeholder and Community Relations
Environment, Safety & Health Directorate
Environmental Protection Division
Environmental Information Management System Group
Groundwater Protection Group

Office of Educational Programs
Information Services Division
Media & Communications Office and Production Services
Facilities and Operations Directorate
Radiological Control Division

A Note from the Editor

Throughout the Site Environmental Report, there are many references to Brookhaven National Laboratory (BNL), the U.S. Department of Energy (DOE), and the U.S. Environmental Protection Agency (EPA). These acronyms, and others that are explained in each chapter, are used interchangeably with their spelled-out forms as an aid to readers. The most up-to-date, accurate version of this report is online at <https://www.bnl.gov/esh/env/ser/>.

Contents

Executive Summary	iii
Acknowledgments	xiii
List of Tables	xxi
List of Figures	xxii

CHAPTER 1: INTRODUCTION

1.1 Laboratory Mission and Policy	1-1
1.2 Research and Discoveries	1-2
1.3 History	1-2
1.4 Facilities and Operations	1-8
1.5 Location, Local Population, and Local Economy	1-9
1.6 Geology and Hydrology	1-10
1.7 Climate	1-14
1.8 Natural Resources	1-14
1.9 Cultural Resources	1-15
References and Bibliography	1-15

CHAPTER 2: ENVIRONMENTAL MANAGEMENT SYSTEM

2.1 Integrated Safety Management and ISO 14001	2-2
2.2 Environmental, Safety, Security, and Health Policy	2-3
2.3 Planning	2-3
2.3.1 Environmental Aspects	2-3
2.3.2 Compliance Obligations	2-3
2.3.3 Objectives and Targets	2-4
2.3.4 Environmental Management Programs	2-4
2.3.4.1 Compliance	2-4
2.3.4.2 Groundwater Protection	2-4
2.3.4.3 Waste Management	2-5
2.3.4.4 Pollution Prevention and Waste Minimization	2-7
2.3.4.5 Water Conservation	2-10
2.3.4.6 Energy Management and Conservation	2-11
2.3.4.7 Natural and Cultural Resource Management Programs	2-13
2.3.4.8 Environmental Restoration	2-14
2.4 Implementing the Environmental Management System	2-16
2.4.1 Structure and Responsibility	2-16
2.4.2 Communication and Community Involvement	2-16

2.4.2.1 Communication Forums.....	2-17
2.4.2.2 Community Involvement in Cleanup Projects.....	2-18
2.4.3 Monitoring and Measurement.....	2-19
2.4.3.1 Compliance Monitoring.....	2-19
2.4.3.2 Restoration Monitoring.....	2-20
2.4.3.3 Surveillance Monitoring.....	2-20
2.4.4 EMS Assessments.....	2-22
2.5 Environmental Stewardship at BNL.....	2-22
References and Bibliography.....	2-23

CHAPTER 3: COMPLIANCE STATUS

3.1 Compliance with Requirements.....	3-2
3.2 Compliance With Requirements.....	3-2
3.2.1 Existing Permits.....	3-2
3.2.2 New or Modified Permits.....	3-2
3.2.2.1 New York State Wetlands and Wild, Scenic, Recreational Rivers Act....	3-2
3.2.2.2 Title V Permit.....	3-2
3.3 NEPA Assessments.....	3-9
3.4 Preservation Legislation.....	3-9
3.5 Clean Air Act (CAA).....	3-9
3.5.1 Conventional Air Pollutants.....	3-9
3.5.1.1 Boiler Emissions.....	3-9
3.5.1.2 Ozone-Depleting Substances.....	3-10
3.5.2 Hazardous Air Pollutants.....	3-10
3.5.2.1 Maximum Available Control Technology.....	3-10
3.5.2.2 Asbestos.....	3-11
3.5.2.3 Radioactive Airborne Emissions.....	3-11
3.6 Clean Water Act.....	3-11
3.6.1 Sewage Treatment Plant.....	3-12
3.6.2 Recharge Basins and Stormwater.....	3-16
3.7 Safe Drinking Water Act.....	3-18
3.7.1 Potable Water.....	3-18
3.7.2 Cross-Connection Control.....	3-23
3.7.3 Underground Injection Control.....	3-24
3.8 Preventing and Reporting Spills.....	3-24
3.8.1 Preventing Oil Pollution and Spills.....	3-24
3.8.2 Emergency Reporting Requirements.....	3-24
3.8.3 Spills and Releases.....	3-25
3.8.4 Major Petroleum Facility License.....	3-25
3.8.5 Chemical Bulk Storage.....	3-26

3.8.6 County Storage Requirements.....	3-26
3.9 RCRA Requirements	3-27
3.10 Polychlorinated Biphenyls.....	3-28
3.11 Pesticides	3-28
3.12 Wetlands and River Permits	3-28
3.13 Protection of Wildlife.....	3-29
3.13.1 Endangered Species Act.....	3-29
3.13.2 Migratory Bird Treaty Act	3-30
3.13.3 Bald and Golden Eagle Protection Act.....	3-30
3.14 Public Notification of Clearance of Property	3-31
3.15 External Audits and Oversight	3-31
3.15.1 Regulatory Agency Oversight	3-31
3.15.2 DOE Assessments/Inspections.....	3-31
3.15.3 Environmental Multi-Topic Assessment.....	3-31
3.15.4 Nevada National Security Site.....	3-32
3.16 Agreements, Enforcement Actions, and Other Environmental Reports.....	3-33
References and Bibliography	3-33

CHAPTER 4: AIR QUALITY

4.1 Radiological Emissions.....	4-1
4.2 Facility Monitoring	4-1
4.2.1 High Flux Beam Reactor.....	4-1
4.2.2 Brookhaven Linac Isotope Producer	4-2
4.2.3 Target Processing Laboratory	4-3
4.2.4 Additional Minor Sources	4-3
4.2.5 Nonpoint Radiological Emission Sources.....	4-3
4.3 Ambient Air Monitoring	4-3
4.3.1 Gross Alpha and Beta Airborne Activity	4-4
4.3.2 Airborne Tritium	4-5
4.4 Nonradiological Airborne Emissions.....	4-5
4.5 Greenhouse Gas Emissions	4-7
References and Bibliography.....	4-10

CHAPTER 5: WATER QUALITY

5.1 Surface Water Monitoring Program.....	5-1
5.2 Sanitary System Effluents	5-3
5.2.1 Sanitary System Effluent – Radiological Analyses.....	5-4
5.2.2 Sanitary System Effluent – Nonradiological Analyses	5-6
5.3 Process-Specific Wastewater	5-6

5.4 Recharge Basins	5-7
5.4.1 Recharge Basins – Radiological Analyses.....	5-10
5.4.2 Recharge Basins – Nonradiological Analyses.....	5-11
5.4.3 Stormwater Assessment	5-12
5.5 Peconic River Surveillance.....	5-14
5.5.1 Peconic River – Radiological Analyses.....	5-15
5.5.2 Peconic River – Nonradiological Analyses.....	5-15
References and Bibliography.....	5-15

CHAPTER 6: NATURAL AND CULTURAL RESOURCES

6.1 Natural Resource Management Program.....	6-1
6.1.1 Identification and Mapping	6-1
6.1.2 Habitat Protection and Enhancement	6-3
6.1.2.1 Salamander Protection Efforts.....	6-3
6.1.2.2 Banded Sunfish	6-4
6.1.2.3 Migratory Birds	6-4
6.1.2.4 Bald Eagle	6-5
6.1.2.5 Northern Long-eared Bat.....	6-5
6.1.3 Population Management	6-5
6.1.3.1 Wild Turkey	6-5
6.1.3.2 White-Tailed Deer.....	6-5
6.1.4 Compliance Assurance and Potential Impact Assessment.....	6-6
6.2 Upton Ecological and Research Reserve.....	6-6
6.3 Monitoring Flora and Fauna	6-7
6.3.1 Deer Sampling.....	6-7
6.3.1.1 Cesium-137 in White-Tailed Deer	6-8
6.3.2 Other Animals Sampled.....	6-13
6.3.3 Fish Sampling.....	6-13
6.3.3.1 Fish Population Assessment	6-13
6.3.4 Vegetation Sampling.....	6-14
6.3.4.1 Grassy Plants and Soil	6-14
6.4 Precipitation Monitoring.....	6-14
6.4.1 Mercury Monitoring of Precipitation	6-14
6.5 Wildlife Programs	6-14
6.6 Cultural Resource Activities	6-16
References and Bibliography.....	6-17

CHAPTER 7: GROUNDWATER PROTECTION

7.1 The BNL Groundwater Protection Management Program.....	7-1
7.1.1 Prevention	7-1
7.1.2 Monitoring	7-2
7.1.3 Restoration.....	7-2
7.1.4 Communication	7-2
7.2 Groundwater Protection Performance	7-2
7.3 Groundwater Monitoring Programs	7-3
7.4 Groundwater Monitoring Results	7-3
7.5 Groundwater Treatment Systems	7-7
References and Bibliography.....	7-10

CHAPTER 8: RADIOLOGICAL DOSE ASSESSMENT

8.0 Introduction.....	8-2
8.1 Direct Radiation Monitoring	8-2
8.1.1 Ambient Radiation Monitoring.....	8-2
8.1.2 Facility Area Monitoring	8-6
8.1.2.1 Neutron Monitoring	8-9
8.2 Dose Modeling for Airborne Radionuclides	8-9
8.2.1 Dose Modeling Program.....	8-10
8.2.2 Dose Calculation Methods and Pathways.....	8-12
8.2.2.1 Maximally Exposed Off-site and On-site Individual.....	8-12
8.2.2.2 Dose Calculation: Fish Ingestion	8-13
8.2.2.3 Dose Calculation: Deer Meat Ingestion	8-13
8.3 Sources: Diffuse, Fugitive, “Other”	8-13
8.3.1 Remediation Work	8-13
8.4 Dose From Point Sources	8-13
8.4.1 Brookhaven Linac Isotope Producer.....	8-13
8.4.2 Target Processing Laboratory.....	8-14
8.4.3 High Flux Beam Reactor.....	8-14
8.4.4 Brookhaven Medical Research Reactor	8-14
8.4.5 Brookhaven Graphite Research Reactor.....	8-14
8.4.6 Waste Management Facility	8-15
8.4.7 Unplanned Releases.....	8-15
8.5 Dose from Ingestion	8-15
8.6 Dose to Aquatic and Terrestrial Biota.....	8-15
8.7 Dose From All Pathways	8-16
References and Bibliography.....	8-16

CHAPTER 9: QUALITY ASSURANCE

9.1 Quality Program Elements	9-1
9.2 Sample Collection and Handling.....	9-2
9.2.1 Field Sample Handling.....	9-3
9.2.1.1 Custody and Documentation	9-3
9.2.1.2 Preservation and Shipment	9-3
9.2.2 Field Quality Control Samples.....	9-3
9.2.3 Tracking and Data Management.....	9-4
9.3 Sample Analysis.....	9-4
9.3.1 Qualifications.....	9-5
9.4 Verification and Validation of Analytical Results	9-5
9.4.1 Checking Results	9-7
9.5 Contract Analytical Laboratory QA/QC	9-7
9.6 Performance or Proficiency Evaluations.....	9-7
9.6.1 Summary of Test Results.....	9-7
9.6.1.1 Radiological Assessments	9-9
9.6.1.2 Nonradiological Assessments	9-9
9.7 Audits	9-9
9.8 Conclusion.....	9-10
References and Bibliography	9-10
Appendix A: Glossary.....	A-1
Acronyms and Abbreviations.....	A-1
Technical Terms.....	A-5
Appendix B: Understanding Radiation.....	B-1
Appendix C: Units of Measure and Half-Life Periods	C-1
Appendix D: Federal, State, and Local Laws and Regulations Pertinent to BNL	D-1
Appendix E: BNL Site Sustainability Plan: Status Summary for Fiscal Year 2020	E-1

List of Tables

Table 2-1.	BNL Pollution Prevention, Waste Reduction, and Recycling Programs, 2020.	2-8
Table 2-2.	BNL Recycled Program Summary, 2011-2020.	2-10
Table 2-3.	Summary of BNL 2020 Environmental Restoration Activities	2-15
Table 2-4.	Summary of BNL Sampling Program Sorted by Media, 2020	2-20
Table 3-1.	Federal, State, and Local Environmental Statutes and Regulations Applicable to BNL.....	3-3
Table 3-2.	BNL Environmental Permits.	3-7
Table 3-3.	Analytical Results for Wastewater Discharges to Sewage Treatment Plant Outfall 001	3-12
Table 3-4.	Analytical Results for Wastewater Discharges to Outfalls 002, 005 - 008, and 010.	3-17
Table 3-5.	Potable Water Wells and Potable Distribution System: Analytical Results (Maximum Concentration, Minimum pH Value).....	3-19
Table 3-6.	Potable Water Wells: Analytical Results for Principal Organic Compounds, Synthetic Organic Chemicals, Pesticides, Micro-Extractables, and Perfluorinated Compounds.	3-21
Table 3-7.	Applicability of EPCRA to BNL	3-25
Table 3-8.	Summary of Chemical and Oil Spill Reports.....	3-27
Table 3-9.	Existing Agreements and Enforcement Actions Issued to BNL, with Status.	3-32
Table 3-10.	Summary of Other Environmental Occurrence Reports, 2020.....	3-33
Table 4-1.	Airborne Radionuclide Releases from Monitored Facilities.	4-3
Table 4-2.	Gross Activity in Facility Air Particulate Filters.....	4-4
Table 4-3.	Gross Activity Detected in Ambient Air Monitoring Particulate Filters.....	4-4
Table 4-4.	Ambient Airborne Tritium Measurements in 2020.	4-8
Table 4-5.	Central Steam Facility Fuel Use and Emissions (2011–2020).....	4-9
Table 5-1.	Tritium and Gross Activity in Water at the BNL Sewage Treatment Plant (STP).	5-4
Table 5-2.	Radiological Analysis of Samples from BNL On-Site Recharge Basins.....	5-7
Table 5-3.	Water Quality Data for BNL On-Site Recharge Basin Samples.....	5-8
Table 5-4.	Metals Analysis of Water Samples from BNL On-Site Recharge Basins.....	5-9
Table 5-5.	Radiological Results for Surface Water Samples Collected Along the Peconic and Carmans Rivers.	5-11
Table 5-6.	Water Quality Analytical Results for Data for Surface Water Samples Collected along the Peconic and Carmans Rivers.	5-12
Table 5-7.	Metals Analytical Results in Surface Water Samples Collected Along the Peconic and Carmans Rivers.	5-13
Table 6-1.	Federal and New York State Threatened & Endangered Species, Species of Special Concern, & Species of Greatest Conservation Need.....	6-2
Table 6-2.	Radiological Analysis of Deer Tissue (2020).....	6-10
Table 6-3.	Radiological Analysis of Grassy Vegetation and Associated Soils	6-11
Table 6-4.	Precipitation Monitoring (Mercury)	6-11
Table 7-1.	BNL Groundwater Remediation Systems Treatment Summary for 1997 through 2020.....	7-8
Table 8-1.	Five-Year Annual On-Site Direct Ambient Radiation Measurements (2016-2020).....	8-5
Table 8-2.	Five-Year Annual Off-Site Direct Ambient Radiation Measurements (2016-2020).....	8-7
Table 8-3.	Five-Year Annual Facility Area Monitoring Results (2016-2020).....	8-8
Table 8-4.	Five-Year Annual Neutron Monitoring Results (2016-2020).....	8-10
Table 8-5.	Maximally Exposed Off-site Individual Effective Dose Equivalent From Facilities or Routine Processes, 2020....	8-11
Table 8-6.	Five-Year Site Dose Summary, 2020.	8-14
Table 8-7.	Five-Year Annual Maximally Exposed Onsite Individual Dose (2016-2020).....	8-15
Table 9.1.	Summary of Detections in Trip and Field Blank Samples.....	9-6
Table 9.2.	Summary Results of 2020 DOE CAP Audits	9-9

List of Figures

Figure 1-1.	Major Scientific Facilities at BNL.....	1-6
Figure 1-2.	Major Support and Service Facilities at BNL.....	1-7
Figure 1-3.	BNL Groundwater Flow Map.....	1-9
Figure 1-4.	BNL Wind Rose (2020).	1-11
Figure 1-5.	BNL 2020 Monthly Mean Temperature versus 71-Year Monthly Average.	1-12
Figure 1-6.	BNL 2020 Annual Mean Temperature Trend (71 Years).....	1-12
Figure 1-7.	BNL 2020 Monthly Precipitation versus 71-Year Monthly Average.	1-13
Figure 1-8.	BNL 2020 Annual Precipitation Trend (71 Years).....	1-13
Figure 2-1a.	Hazardous Waste Generation from Routine Operations, 2001 – 2020.	2-5
Figure 2-1b.	Mixed Waste Generation from Routine Operations, 2001 – 2020.	2-5
Figure 2-1c.	Radioactive Waste Generation from Routine Operations, 2001 – 2020.....	2-5
Figure 2-1d.	Hazardous Waste Generation from ER and Nonroutine Operations, 2001 – 2020.....	2-6
Figure 2-1e.	Mixed Waste Generation from ER and Nonroutine Operations, 2001 – 2020.....	2-6
Figure 2-1f.	Radioactive Waste Generation from ER and Nonroutine Operations, 2001 – 2020.	2-6
Figure 2-2.	Annual Potable Water Use, 1999 – 2020.....	2-11
Figure 2-3.	BNL Building Energy Performance for 2020.	2-14
Figure 3-1.	Maximum Concentrations of Copper Discharged from the BNL Sewage Treatment Plant, 2015 – 2020.....	3-13
Figure 3-2.	Maximum Concentrations of Iron Discharged from the BNL Sewage Treatment Plant, 2015 – 2020.....	3-13
Figure 3-3.	Maximum Concentrations of Lead Discharged from the BNL Sewage Treatment Plant, 2015 – 2020.....	3-14
Figure 3-4.	Maximum Concentrations of Mercury Discharged from the BNL Sewage Treatment Plant, 2015 – 2020.....	3-14
Figure 3-5.	Maximum Concentrations of Nickel Discharged from the BNL Sewage Treatment Plant, 2015 – 2020.....	3-15
Figure 3-6.	Maximum Concentrations of Silver Discharged from the BNL Sewage Treatment Plant, 2015 – 2020.....	3-15
Figure 3-7.	Maximum Concentrations of Zinc Discharged from the BNL Sewage Treatment Plant, 2015 – 2020.....	3-15
Figure 4-1.	Air Emission Release Points Subject to Monitoring.	4-2
Figure 4-2.	BNL On-Site Ambient Air Monitoring Stations.....	4-5
Figure 4-3.	Airborne Gross Beta Concentration Trend Recorded at Station P7.....	4-7
Figure 4-4.	BNL Scope 3 Greenhouse Gases: Federal Impact of Covid-19.....	4-9
Figure 5-1.	Sampling Stations for Surface Water and Fish.....	5-2
Figure 5-2.	Schematic of BNL's Sewage Treatment Plant (Recharge Basin Discharge)	5-3
Figure 5-3.	BNL Recharge Basin/Outfall Locations.....	5-5
Figure 5-4.	Schematic of Potable Water Use and Flow at BNL.....	5-6
Figure 6-1.	Deer Sample Locations, 2016 – 2020.	6-9
Figure 6-2.	Comparison of Cs-137 Values in Deer Flesh	6-12
Figure 6-3.	Ten-Year Trend of Cs-137 Concentrations in Deer Flesh	6-12
Figure 6-4.	Vegetation and Soil Sampling Locations.....	6-15
Figure 7-1.	Groundwater Flow and Water Table Elevation (January 2020) with Supply and Remediation Wells Shown.....	7-4
Figure 7-2.	Extent of VOC Plumes.....	7-5
Figure 7-3.	Extent of Radionuclide Plumes.....	7-6
Figure 7-4.	Locations of BNL Groundwater Remediation Systems.	7-9

Figure 8-1.	On-Site TLD Locations.....	8-3
Figure 8-2.	Off-Site TLD Locations.	8-4
Figure 8-3.	On-Site Neutron TLD Locations.	8-8
Figure 9-1.	Flow of Environmental Monitoring QA/QC Program Elements.....	9-2
Figure 9-2.	Summary of Scores in the Radiological Proficiency Evaluation Programs.....	9-8
Figure 9-3.	Summary of Scores in the Nonradiological Proficiency Evaluation Programs.	9-8

Intentionally Left Blank