

Environmental Management System

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Brookhaven Science Associates (BSA), the contractor operating the Laboratory on behalf of the Department of Energy (DOE), takes environmental stewardship very seriously. As part of its commitment to environmentally responsible operations, BSA has established the Brookhaven National Lab (BNL) Environmental Management System (EMS). An EMS ensures that environmental issues are systematically identified, controlled, and monitored. Moreover, an EMS provides mechanisms for responding to changing environmental conditions and requirements, reporting on environmental performance, and reinforcing continual improvement.

The Laboratory's EMS was designed to meet the rigorous requirements of the globally recognized International Organization for Standardization (ISO) 14001 Environmental Management Standard, which encompasses ideals such as compliance, pollution prevention, and community involvement. Annual audits by an independent third party are required to maintain an EMS registration; an audit of the entire EMS occurs every three years. In 2021, an EMS certification audit recertified BNL's continued conformance to the ISO 14001 Standard.

BNL documents its efforts to implement sustainable business practices into infrastructure and operations in its Site Sustainability Plan (SSP). The areas of focus are energy and water conservation, waste reduction, recycling, purchase of environmentally friendly products, greenhouse gas management, and other adaptation and resilience planning. Future objectives are expected to include net-zero carbon-free emission goals in line with larger DOE plans to address the impacts from climate change.

The Laboratory continues its strong support of its Pollution Prevention Program, which seeks ways to eliminate waste and toxic materials on site, but also to promote sustainable business activities. The program generates new ideas to grow the Lab's existing recycling program or otherwise improve sustainable operations. In 2021, the Pollution Prevention Program resulted in nearly \$1.5 million in cost avoidance or savings and resulted in the reduction or reuse of approximately 2.8 million pounds of waste. Also, the Pollution Prevention Program funded seven new proposals, investing approximately \$14,000. The proposals involved reducing risk, promoting use of bio-friendly alternative products, improving small energy efficiency projects, and promoting overall environmentally sustainable business practices. Fewer proposals were able to be completed this year due to impact on available internal labor for equipment installations and impact on staff overall because of the COVID-19 pandemic.

The ISO 14001-registered EMS and Pollution Prevention Program continued to contribute to the Laboratory's success in improving sustainable operations. Support was also provided in 2021 to line organizations for lab cleanouts and disposal of chemicals. As a testament to its strong environmental program, the Lab received the Green Electronics Council's Electronic Product Environmental Assessment Tool (EPEAT) Gold Award, the DOE's GreenBuy Award, and a second GreenBuy Superior Award.

BNL continues to address legacy environmental issues and openly communicates with neighbors, regulators, employees, and other interested parties on environmental issues and cleanup progress on site. Even during the challenges that the COVID-19 pandemic posed, BNL was successful in maintaining a high level of communication and interaction with the community, regulators, and employees. This was accomplished through virtual meetings of the Community Advisory Committee, Brookhaven Executive Roundtable, virtual tours, a reenergized virtual speakers bureau, and monthly interagency calls with regulators. BNL is committed to transparency and open communication with its internal and external stakeholders.

2.1 INTEGRATED SAFETY MANAGEMENT AND ISO 14001

The Laboratory's Integrated Safety Management System (ISMS) integrates environmental protection, pollution prevention, safety, health, and quality (ESH&Q) management into all work planning and execution. The purpose of BNL's ISMS is to ensure that the way we work integrates DOE's five Core Functions and seven Guiding Principles into all work processes. The five Core Functions, as defined by DOE P 450.4, Safety Management System Policy, are:

- *Define the scope of work:* Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.
- *Analyze the hazards:* Hazards associated with the work are identified, analyzed, and categorized.
- *Develop and implement hazard controls:* Applicable standards and requirements are identified and agreed-upon; controls to prevent/mitigate hazards are identified; the safety envelope is established; and controls are implemented.
- *Perform work within controls:* Readiness is confirmed, and work is performed safely.
- *Provide feedback and continuous improvement:* Feedback information on the adequacy of controls is gathered; opportunities for improving the definition and planning of work are identified and implemented.

The seven Guiding Principles, also as defined by DOE P 450.4, are:

- *Line management responsibility for safety:* Line management is directly responsible for the protection of the workers, the public, and the environment.
- *Clear roles and responsibilities:* Clear and unambiguous lines of authority and responsibility for ensuring safety are established and maintained at all organizational levels within the Department and its contractors.
- *Competence commensurate with responsibilities:* Personnel possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities.
- *Balanced priorities:* Resources are effectively allocated to address safety, programmatic,

and operational considerations. Protecting the workers, the public, and the environment is a priority whenever activities are planned and performed.

- *Identification of safety standards and requirements:* Before work is performed, the associated hazards are evaluated and an agreed-upon set of safety standards and requirements is established which, if properly implemented, will provide adequate assurance that the workers, public, and environment are protected from adverse consequences.
- *Hazard controls tailored to work being performed:* Administrative and engineering controls to prevent and mitigate hazards shall be tailored to the work being performed and associated hazards.
- *Operations authorization:* The conditions and requirements to be satisfied for operations to be initiated and conducted shall be clearly established and agreed upon.

The integrated processes within ISMS contributed to BNL achieving ISO 14001 registration. The ISO 14001 Standard is globally recognized and defines the structure of an organization's EMS for purposes of improving environmental performance. The process-based structure of the ISO 14001 Standard is based on the "Plan-Do-Check-Act" improvement cycle. The ISO 14001 standard requires an organization to develop a policy, create plans to implement the policy, implement the plans, check progress and take corrective actions, and review the system periodically to ensure its continuing suitability, adequacy, and effectiveness.

The Laboratory has been officially registered to the ISO 14001 Standard since 2001. The Laboratory was the first DOE Office of Science Laboratory to achieve this registration. The certification requires the Laboratory to undergo annual audits by an accredited, third-party registrar to assure that the system is maintained. BNL's external certification organization, ERM Certification Verification Services, conducted an external certification audit of BNL's conformance to the ISO 14001 Standard in July 2021. The certification audit identified one nonconformance regarding the independence of the Internal Assessment, but determined that the Laboratory was in full conformance to the Standard

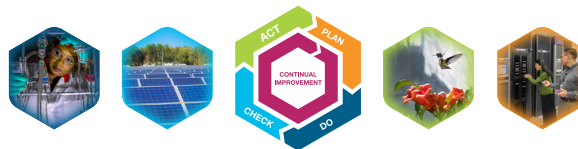
and, therefore, reissued BNL's certification to the standard on September 22, 2021.

2.2 ENVIRONMENTAL, SAFETY, SECURITY, AND HEALTH POLICY

The cornerstone of an EMS is a commitment to environmental protection at the highest levels of an organization. BNL's environmental commitments are incorporated into a comprehensive Environmental, Safety, Security, and Health (ESSH) Policy. The policy was reviewed and revised during 2021, reissued, and signed by the Laboratory Director. It states the Laboratory's commitment to environmental stewardship, the safety of the public and BNL employees, and the security of the site with minor revisions reflecting a stronger emphasis on sustainability in addition to compliance. The policy continues as a statement of the Laboratory's intentions and principles regarding overall environmental performance. It provides a framework for planning and action and is included in employee, guest, and contractor training programs. The ESSH Policy is posted throughout the Laboratory and on the BNL website at <http://www.bnl.gov/esh/policy.php>. The Policy's goals and commitments focus on compliance, pollution prevention, community outreach, and continual improvement:

- **Environment:** We protect the environment, conserve resources, and implement sustainable business practices that protect our future.
- **Safety:** We maintain a safe workplace. We plan our work and perform it safely. We take responsibility for the safety of ourselves, coworkers, and guests.
- **Security:** We protect people, property, information, computing systems, and facilities.
- **Health:** We protect human health within our boundaries and in the surrounding community.
- **Compliance:** We achieve and maintain compliance with applicable ESSH requirements.
- **Community:** We maintain open, proactive, and constructive relationships with our employees, neighbors, regulators, the U.S. Department of Energy, and other stakeholders.
- **Continual Improvement:** We continually improve ESSH performance.

Environmental, Safety, Security, and Health Policy



This document is a statement of Brookhaven National Laboratory's Environmental, Safety, Security, and Health (ESSH) policy. Brookhaven Lab is a world leader in scientific research and performs this work in an environmentally responsible, safe, and secure manner.

I expect every employee, contractor, and guest to take personal responsibility for adhering to the following principles:

Environment	We protect the environment, conserve resources, and implement sustainable business practices that protect our future.
Safety	We maintain a safe workplace. We plan our work and perform it safely. We take responsibility for the safety of ourselves, coworkers, and guests.
Security	We protect people, property, information, computing systems, and facilities.
Health	We protect human health within our boundaries and in the surrounding community.
Compliance	We achieve and maintain compliance with applicable ESSH requirements.
Community	We maintain open, proactive, and constructive relationships with our employees, neighbors, regulators, the U.S. Department of Energy, and other stakeholders.
Continual Improvement	We continually improve ESSH performance.

In addition to my annual review of Brookhaven Lab's progress on ESSH 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.

Signed 
Doon Gibbs, Director

October 13, 2021



2.3 PLANNING

The planning requirements of the ISO 14001 Standard require BNL to identify the environmental aspects and impacts of its activities, products, and services; evaluate applicable compliance obligations; establish objectives and targets; create action plans to achieve the objectives and targets; and identify and address risks and opportunities that can impact the success of the EMS.

2.3.1 Environmental Aspects

An "environmental aspect" is any element of an organization's activities, products, and services that can impact the environment. As required by the ISO 14001 Standard, BNL evaluates its operations, identifies the aspects that can impact the environment, and determines which of those impacts are significant. The Laboratory's criteria for significance are based on actual and perceived impacts of its operations and on regulatory requirements. BNL uses its work planning process to identify and review environmental aspects

associated with activities. A Process Assessment Procedure is used for facilities and equipment or for deeper analysis of activities not sufficiently covered by work planning. Evaluations are documented on work plans and Process Assessment Forms (PAFs).

Environmental professionals work closely with Laboratory personnel to ensure that work plans, PAFs, and other related reviews thoroughly capture all aspects, requirements, and associated environmental controls. Aspects and impacts are evaluated annually to ensure that they continue to reflect stakeholder concerns and changes in regulatory requirements.

2.3.2 Compliance Obligations

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

BNL follows DOE Order 436.1, Departmental Sustainability. This order has historically been based on Federal Executive Orders that establish 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 436.1 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 the most recent Executive Order (EO) 13834, Efficient Federal Operations (May 2018). However, EO 13834 was partially revoked by EO 13990, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis (January 20, 2021). This temporarily eliminated Federal-level sustainability goals, although DOE maintained Departmental-level sustainability goals in the DOE 2020 Sustainability Report and Implementation Plan. On December 8, 2021, EO 13834 was revoked in its entirety by EO 14057, Catalyzing

Clean Energy Industries and Jobs Through Federal Sustainability, which set new Federal-level sustainability goals. All of the goals related to the new executive orders are consolidated in the Federal Sustainability Plan (www.sustainability.gov/federalsustainabilityplan/). Each DOE facility is required to have a 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, which can be found in Appendix E and identifies the DOE SSP goals, the Laboratory's performance in 2021, and future planned actions and contributions.

2.3.3 Objectives and Targets

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

- Meeting the intent and goals of relevant executive orders or other requirements;
- Significant environmental aspects;
- Risk and vulnerability (primarily, threat to the environment);
- Compliance obligations (e.g., laws, regulations, permits, enforcement actions, and memorandums of agreement);
- Commitments in the ESSH Policy to regulatory agencies and to the public;
- Importance to DOE, the public, employees, and other stakeholders.

Laboratory-level objectives and targets are developed on a fiscal year (FY) schedule. For FY 2021, BNL's environmental objectives included addressing emerging contaminants in drinking water, supporting the Lab's scientific mission by providing environmental support to significant research projects, addressing discharge compliance issues connected to cleaning and maintaining cooling

water systems treated for the legionella bacterium as directed by New York State, maintaining ISO 14001 certification and the Laboratory's performance in purchasing environmentally preferable items, and reducing the overall hazard footprint by reducing chemical inventories.

2.3.4 Environmental Management Programs

The Environmental Protection Division (EPD) takes on the largest role for developing action plans for implementing institutional environmental priorities, while other organizations within BNL develop action plans as applicable to their operations. The plans detail how the organization will achieve its environmental objectives and targets, as well as commit the resources necessary to successfully implement both Laboratory-wide and facility-specific programs. BNL has a budgeting system designed to ensure that priorities are balanced and provide resources essential to the implementation and control of the EMS. The Laboratory continues to review, develop, and fund important environmental programs to further integrate environmental stewardship into all facets of its missions.

2.3.4.1 Compliance

BNL has an extensive program to ensure that the Laboratory remains in full compliance with all applicable environmental regulatory requirements and permits. Legislated compliance is outlined by the Clean Air Act, National

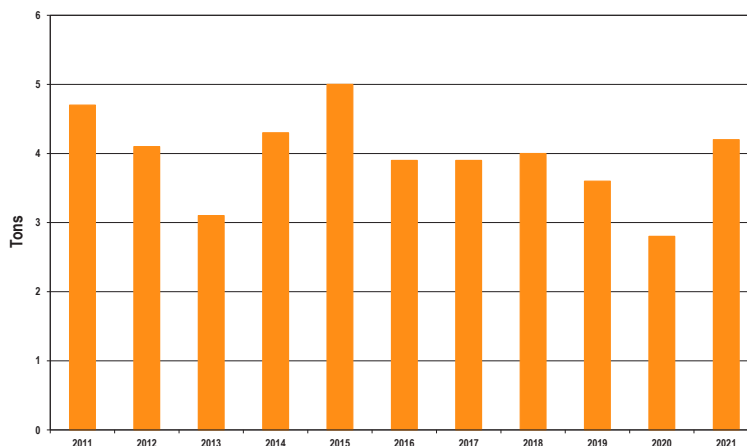


Figure 2-1a. Hazardous Waste Generation from Routine Operations, 2011 – 2021.

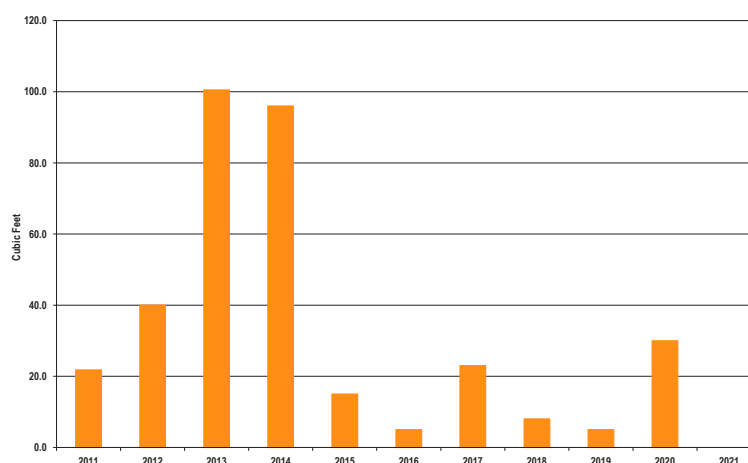


Figure 2-1b. Mixed Waste Generation from Routine Operations, 2011 – 2021.

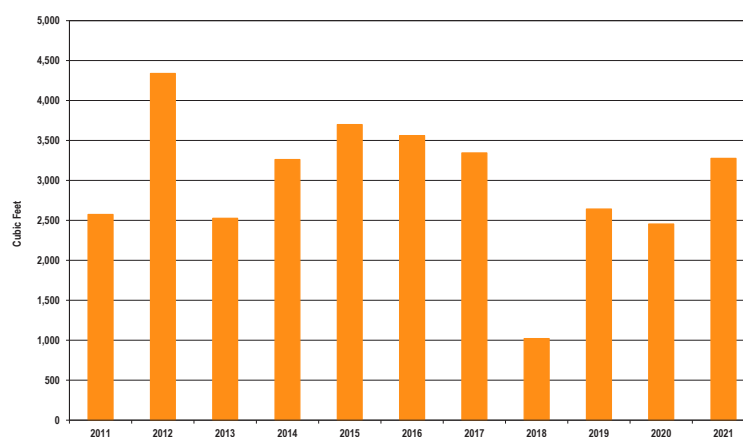


Figure 2-1c. Radioactive Waste Generation from Routine Operations, 2011 – 2021.

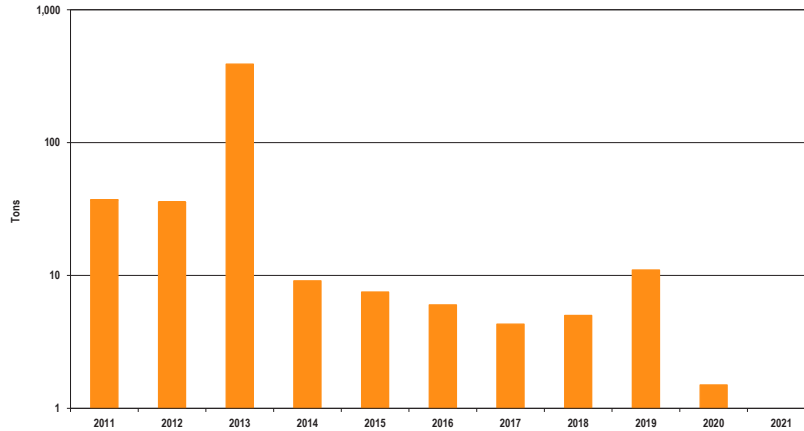


Figure 2-1d. Hazardous Waste Generation from ER and Nonroutine Operations, 2011 – 2021.

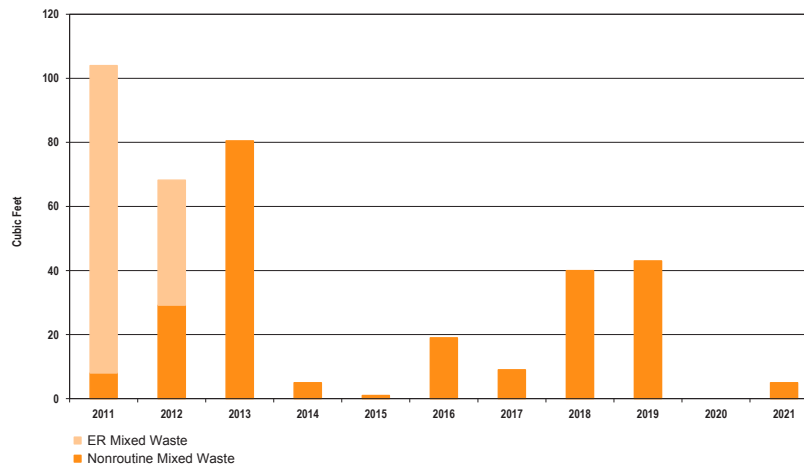


Figure 2-1e. Mixed Waste Generation from ER and Nonroutine Operations, 2011 – 2021.

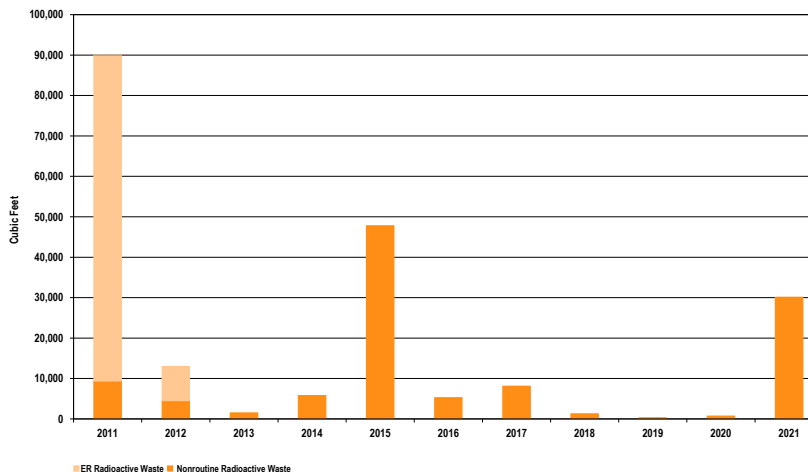


Figure 2-1f. Radioactive Waste Generation from ER and Nonroutine Operations, 2011 – 2021.

Emission Standards for Hazardous Air Pollutants (NES-HAPs), Clean Water Act (e.g., State Pollutant Discharge Elimination System [SPDES]), Safe Drinking Water Act (SDWA), Resource Conservation and Recovery Act (RCRA), and other programs. Other compliance initiatives at the Laboratory involve special projects, such as monitoring drinking water systems for emerging contaminants, establishing a wildland fire program, increasing onsite pollinator habitat, retrofitting or replacing air conditioning equipment refrigerants, and managing legacy facilities. See Chapter 3 for a list of regulatory programs to which BNL subscribes and a thorough discussion of these programs and their status.

2.3.4.2 Groundwater Protection

BNL's Groundwater Protection Program is designed to prevent negative impacts to groundwater and restore groundwater quality by integrating pollution prevention efforts, monitoring, groundwater restoration projects, and communicating performance. The Laboratory has developed a Groundwater Protection Contingency Plan that defines an orderly process for quickly verifying the results and taking corrective actions in response to unexpected monitoring results (BNL 2018). Key elements of the groundwater program are full, timely disclosure of any off-normal occurrences and regular communication on the performance of the program.

Chapter 7 and SER Volume II, Groundwater Status Report, provide additional details about this program, its performance, and monitoring results for 2021.

2.3.4.3 Waste Management

Due to the world-class research it conducts, BNL generates a wide range of wastes. These wastes include materials common to many businesses and industries, such as office wastes (e.g., paper, plastic, etc.), aerosol cans, batteries, paints, and oils. However, the Laboratory's unique scientific activities also generate specialized waste streams that are subject to additional regulation and special handling, including radioactive, hazardous, industrial, and mixed waste. BNL's Waste Management Facility (WMF), operated by the EPD, is responsible for collecting, storing, transporting, and managing the disposal of these specialized wastes. This modern facility was designed for handling hazardous, industrial, radioactive, and mixed waste, and is comprised of two staging areas: a facility for hazardous, industrial, and mixed waste in Building 855, regulated by RCRA, and a reclamation building for radioactive material in Building 865. The RCRA building is managed under a permit issued by the New York State Department of Environmental Conservation (NYSDEC).

These buildings are used for short-term storage of waste before it is packaged or consolidated for off-site shipment to permitted treatment and disposal facilities. Waste can either be generated from routine operations, defined as ongoing industrial and experimental operations, or from non-routine, defined by that generated by remediation projects, facility decommissioning activities, or one-time events (e.g., lab cleanouts). In 2021, BNL generated the following types and quantities of waste from routine operations:

- Hazardous waste: 4.2 tons
- Mixed waste: 0 ft³
- Radioactive waste: 3,276 ft³

Hazardous waste from routine operations increased during 2021, as shown in Figure 2-1a, as the Lab recovered from the limited operational status caused by the COVID-19 pandemic. No mixed waste was generated. Radioactive waste generation stayed within the range reflecting

normal operations, as shown in Figure 2-1c.

BNL's inventory of legacy waste has been significantly reduced over the years. Figures 2-1d through 2-1f show waste generated from non-routine operations. Waste generation from these activities can vary significantly from year to year as various decommissioning and remedial actions are conducted. The increase in non-routine radioactive and mixed waste generation during 2021 is due to the demolition of the former Hot Laundry Facility (Building 650).

2.3.4.4 Pollution Prevention and Waste Minimization

The BNL Pollution Prevention (P2) Program reflects national and DOE pollution prevention goals and policies and represents an ongoing effort to make pollution prevention and waste minimization an integral part of BNL's operating philosophy.

Pollution prevention and waste reduction goals have been incorporated into the DOE contract with BSA, BNL's ESSH Policy, the PEMP associated with the Laboratory's operating contract with DOE, and BNL's SSP. Key elements of the P2 Program include:

- Eliminate or reduce emissions, effluents, and waste at the source where possible, as practicable;
- Procure environmentally preferable products (known as "affirmative procurement");
- Conserve natural resources and energy;
- Reuse and recycle materials;
- Achieve or exceed BNL/DOE waste minimization, P2, recycling, and affirmative procurement goals;
- Comply with applicable requirements (e.g., New York State Hazardous Waste Reduction Goal, executive orders, etc.);
- Reduce waste management costs;
- Implement P2 projects;
- Improve employee and community awareness of P2 goals, plans, and progress.

The BNL P2 and recycling programs have achieved reductions in waste generated by routine operations, as shown in Figures 2-1a through 2-1c, since 2018, radioactive waste generation rates have increased due to BNL's growing Medical Isotope Research Program. Hazardous waste generation rates are also increasing despite the

Table 2-1. BNL Pollution Prevention, Waste Reduction, and Recycling Programs, 2021.

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled, or Conserved in 2021	Waste Type	Potential Costs for Treatment and Disposal	Revenue/(Cost) of Recycle, Prevention	Estimated Cost Savings	Project Description Details
Office Paper	Recycled	48,820	Regular Trash	\$5,858	(\$13,000)	\$8,353	Collected and transported to a transfer facility for recycling along with regular trash, daily construction, and demolition debris (C&D) from daily maintenance activities and other recyclables. Savings for all are based on cost to dispose of as trash based on an average cost of disposal of \$240/ton. The cost of recycling is a flat fee of \$13K for all paper and cardboard and no cost/revenue for bottles and cans.
Cardboard	Recycled	129,120	Regular Trash	\$15,494			
Bottles/Cans	Recycled	10,820	Regular Trash	\$1,298	\$0	\$1,298	
Printer Toner Cartridges	Recycled	906	Regular Trash	\$109	\$0	\$109	Printer toner cartridges were picked up by vendor for recycling, saving the cost to dispose as regular trash at \$240/ton.
Metals	Recycled	924,440	Regular Trash	\$110,933	\$36,978	\$147,910	Cost avoidance was based on \$240/ton for disposal as trash, plus \$37,710 revenue based on \$0.04/lb.
Electronic Waste	Recycled	127,240	Electronic Waste	\$15,269	\$50,896	\$66,165	Cost avoidance was based on \$240/ton for disposal as trash, plus \$30,248 revenue based on \$0.40/lb.
Electronic Reuse	Reuse	17,138	Electronic Waste	\$1,148,000	(\$6,855)	\$1,141,145	The Laboratory resues electronic equipment if possible. If not reused, the electronics would provide scrap metal revenue at \$0.40/lb. Savings are based on the cost of purchasing the reused items as new items minus the scrap value.
Building 452 Oil Skimmer	Source Reduction	0	Industrial Waste	\$0	\$0	\$0	Reduced oily water waste stream (non-halogenated oil) from air compressors by skimming off oil and leaving water phase. Water may be discharged to sanitary system. In 2021, no oil was sent for reprocessing.
Used Motor Oil	Energy Recovery	10,384	Industrial Waste	\$623	\$4,095	\$4,718	Used motor oil from Building 452 and the motor pool was given to Strebels Laundry Service to fire their boilers. In 2021, they collected 1,247 gallons (10,400 lbs) of oil at \$0.50 /ga, which avoided the costs for disposal as used oil at \$43.81/drum and 25 shipping drums at \$120/drum.

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Table 2-1. BNL Pollution Prevention, Waste Reduction, and Recycling Programs, 2021

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled, or Conserved in 2021	Waste Type	Potential Costs for Treatment and Disposal	Revenue/(Cost) of Recycle, Prevention	Estimated Cost Savings	Project Description Details
Blasocut Machining Coolant	Recycled/ Reused	4,348	Industrial Waste	\$1,638	\$19,180	\$20,818	Central Shops Division operates a recycling system that reclaims Blasocut, an aqueous machining coolant. Recycling involves aeration, centrifuge, and filtration. The system provides reclaimed coolant for use Lab-wide, reducing purchases of new Blasocut. The associated cost avoidance is based on the cost to dispose of ten drums of unreclaimed Blasocut as industrial waste/used oil at \$43.81; the empty drums needed to disposal as industrial waste (\$120/drum). The cost benefit of recycling is based on savings of using ten drums of recycled material versus purchasing virgin Blasocut @ \$1,918/drum. Ongoing staffing and mechanical issues have limited the use of the machine shop reducing the amount of blasocut consumed as compared to past activities. Only 521 gallons (4,348 lbs.) of Blasocut lubricant were recycled during 2021.
Concrete Reuse	Recycled/ Reused	0	C&D Debris	\$0	\$0	\$0	Concrete from demolitions was stored onsite and crushed for reuse in other construction projects (e.g., sidewalks and parking lots). No onsite stored concrete was crushed for reuse during 2021.
Tires	Recycled	13,720	Regular Trash	\$1,646	\$0	\$1,646	Truck tires were sent for recycling from the motor pool. Cost savings were based on cost to dispose of as trash at \$240/ton.
Lead Acid Batteries	Recycled	27,560	Universal Waste	\$9,922	\$0	\$9,922	Universal waste disposal costs for lead and sulfuric acid batteries were avoided by sending directly for recycling. No revenue is generated from recycling batteries. Savings are based on disposal as Universal Waste at 0.36/lb.
Lead Scrap	Recycled	0	Hazardous Waste	\$0	\$0	\$0	No lead scrap was recycled during 2021.
Fluorescent Bulbs	Recycled	7,404	Universal Waste	\$2,661	\$0	\$2,661	BNL manages these fluorescent bulbs as RCRA Universal Waste where they are ultimately sent for recycling. There is no other option for managing this waste stream.
Garnet	Recycled	0	Industrial Waste	\$0	\$0	\$0	Garnet used in machine shop was sent for recycling. Cost savings are based on cost to dispose of as Regulated Industrial Waste.
TOTAL		1,321,900		\$1,313,451	\$91,294	\$1,404,744	BNL disposed 493,360 lbs of Regular Trash. BNL's 2021 recycling rate is 73%.

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Table 2-1. BNL Pollution Prevention, Waste Reduction, and Recycling Programs, 2021. (concluded).

Waste Description	Type of Project	Pounds Reduced, Reused, Recycled, or Conserved in 2021	Waste Type	Potential Costs for Treatment and Disposal	Revenue/(Cost) of Recycle, Prevention	Estimated Cost Savings	Project Description Details
2020 - C&D Demo - Metal	Recycled	21,840	Solid Waste	\$1,092	\$0	\$1,092	Debris from the demolition of Apartments 366 and 367 occurred at the end of 2020 for which information wasn't available for the 2021 report. Revenue from the recyclable materials is integrated into the overall cost of the contract so the revenue can't be calculated. Savings are based on the cost to dispose of the recyclable materials as C&D waste based at an average cost of disposal of \$0.05/lb. The concrete was sent off site for crushing and reuse.
2020 - C&D Demo - Glass	Recycled	9,320	Solid Waste	\$466	\$0	\$466	
2020 - C&D Demo - Concrete	Recycled	972,000	Solid Waste	\$48,600	\$0	\$48,600	
C&D Demo - Metal	Recycled	299,600	Solid Waste	\$14,980	\$0	\$14,980	Debris by the demolition of Building 650 (former Hot Laundry Facility) and Building 421. Cost/credit for the recyclable materials is part of the contract with the subcontractor but the exact amount can't be calculated. Savings for all are based on cost to dispose of as trash based on an average cost of disposal of \$0.05/lb. The concrete was sent off site for crushing and reuse.
C&D Demo - Glass	Recycled	2,280	Solid Waste	\$114	\$0	\$114	
C&D Demo - Concrete	Recycled	147,660	Solid Waste	\$7,383	\$0	\$7,383	
TOTAL		1,452,700		\$72,635	\$0	\$72,635	BNL sent 1,797,240 lbs of nonrecyclable C&D waste to a C&D Landfill from the above demo projects and 418,200 from routine operations. BNL's recycling rate for demolition is 40%.

impact of COVID-19 on Laboratory operations. BNL's EMS establishes objectives and targets to drive sustainable business practices, but growth in the research programs at the Lab is creating new waste streams that offset the impact of BNL's P2 efforts. Regardless, P2 efforts still reduce the risk of environmental impacts from BNL operations. Table 2-1 describes the P2 projects implemented through 2021, and provides the number of pounds of materials reduced, reused, or recycled, as well as the estimated cost benefit of each project.

The P2 program also provides funding for the line organizations to implement new hazard reduction or sustainability ideas. During 2021, EPD provided \$14,000 for seven projects that provided an environmental benefit. The projects included improved chemical storage, overfill alarm for oil storage tank, hazardous chemical substitutions, and data center energy improvements. Future projects funded through this process will be added to Table 2.1 when they involve an ongoing, trackable cost/benefit worth reporting.

The implementation of P2 opportunities, recycling programs, and conservation initiatives has reduced both waste volumes and management costs. In 2021, these efforts resulted in nearly \$1.5 million in cost avoidance or savings and approximately 2.8 million pounds of materials being reduced, recycled, or reused annually.

In 2021, BNL collected approximately 462 tons of scrap metal for recycling. Cardboard, office paper, bottles and cans, construction debris, motor oil, lead, automotive batteries, electronic scrap, fluorescent light bulbs, and drill press/ machining coolant were also recycled. Table 2-2 shows the total number of tons of the materials recycled. The baseline recycling rate goal for federal facilities is 50 percent. BNL's annual average recycling rate consistently outperforms the baseline. The 2021 annual recycling rate was 73 percent.

In 2021, BNL's sustainability program was once again honored by receiving the Green Electronics Council's Electronic Product Environmental Assessment Tool (EPEAT) Award for purchasing EPEAT-registered electronic products which meet strict environmental criteria that address the full product lifecycle, from energy conservation to toxic materials to product longevity

Table 2-2. BNL Recycled Program Summary, 2012-2021.

Recycled Waste	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Mixed paper	142	160	150	91	89	84	65	60	34	24.4
Cardboard	100	97	78	12.4	73	74	74	71	43	64.6
Bottles/Cans	18	16.5	17.1	22.1	11	7.9	10.2	10.6	7.7	5.4
Tires	10	7.1	7.6	5.4	6.4	5.2	8.8	11	1.4	6.9
Concrete (crushed/reused onsite)	4,050	3,500	4,000	0	4,200	3,500	0	0	0	0
Used motor oil	6.3	6.2	8.0	5.3	10.9	12.5	9.3	4.0	4.2	5.2
Condensor oil	--	--	--	--	--	--	--	--	--	0
Metals	278	174	256	737	426	621	559	513	234	462
Automotive & UPS batteries	2	2.1	1.4	1.9	1.4	0.6	15	13	30	13.8
Printer/Toner cartridges	2.1	5.6	1.1	1.0	n/a	1.2	1.1	1.0	0.5	0.5
Fluorescent bulbs	7.9	6.8	9.9	8.0	4.8	2.5	2.3	2.3	3.2	3.7
Blasocut coolant	22.4	22.6	19.4	10.2	9.4	7.8	11.7	5.1	2.6	2.2
Electronic reuse	3.2	1.4	10.5	25	17	19	21.7	17.3	7.5	8.6
Scrap electronics	30.9	23	29.3	42	24	23.1	53.3	93.9	37.8	63.6
Garnet	---	---	---	---	---	20.5	21	0	18.3	0
Recycling Subtotal:	4,673	4,022	4,588	961	4,873	4,379	852	802	424	661
Municipal Solid Waste	492	494	499	429	344	386	391	383	252	247
Recycling Rate (%)	63%	76%	58%	77%	67%	69%	69%	68%	63%	73%

Construction and Demolition (C&D) Summary:

Construction Debris (Routine)	380	304	351	372	266	256	208	271	149	209
Demolition Projects:										
Metals	60	90	0	0	0	0	51.5	13	10.9	161
Concrete (Sent offsite)	4,050	3,500	4,000	0	4200	3500	0	491	486	560
Glass	---	---	---	---	---	---	---	1	5	6
Construction and demolition (other recycle)	0	0	0	0	0	0	664	499	0	0
Construction and demolition (landfill)	---	---	---	---	---	---	---	---	452	898
C&D Recycling Rate (%)									46%	40%

Note: All units are tons.

and end-of-life management. BNL also received the DOE's GreenBuy Award and received a second GreenBuy Superior Award after receiving the first during 2020. The GreenBuy Award recognizes DOE sites for purchases of materials that are energy and water efficient and made from biobased or recycled content material. The GreenBuy Superior Award identifies BNL as a site that has achieved GreenBuy Gold status five or more times.

2.3.4.5 Water Conservation

BNL's water conservation program has achieved dramatic reductions in water use since the mid-1990's. The Laboratory continually evaluates water conservation as part of facility upgrades or new construction initiatives. These efforts include more efficient and expanded use of chilled water for cooling and heating/ventilation and air conditioning (HVAC) systems to reduce use of once-through cooling water for other

systems. The Laboratory's goal is to reduce the consumption of water and reduce the possible impact of clean water dilution on STP operations.

Figure 2-2 shows the 20-year trend of water consumption. Total water consumption in 2021 was down slightly from previous years, mainly due to fewer people onsite due to remote working agreements. The water intensity (gallon/gross square foot) also continues to decrease. 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.

2.3.4.6 Energy Management and Conservation

The Laboratory's Energy Management Group continues to reduce energy use and costs by identifying and implementing cost-effective, energy-efficient projects; monitoring energy use and utility bills; and assisting in obtaining the least expensive energy sources possible. The group is responsible for developing, implementing, and coordinating BNL's energy management efforts and assisting DOE in meeting the energy and sustainability goals in EO 13834, DOE Order 436.1, and the U.S. Secretary of Energy's initiatives. The Laboratory's SSP addresses all aspects of the DOE energy, water, transportation, and other sustainability goals. In the future, the SSP will reflect new goals as directed by the DOE as part of the Federal Site Sustainability Plan. The goals will be focused on a reduction of carbon emissions emitted by federal facilities in order to reduce the impact of climate change.

BNL has more than 4.8 million square feet of building space. Many scientific experiments at the Laboratory use particle beams generated and accelerated by electricity, with the particles controlled and aligned by large electromagnets. In 2021, BNL used 261 million kilowatt hours (kWh) of electricity, 52,395 gallons of fuel oil, 12,517 gallons of propane, and 554 million cubic feet of natural gas. Fuel oil and natural gas are used to produce steam at the Central Steam Facility (CSF).

Responding to market conditions, fuel oil and natural gas have been historically used whenever each respective fuel is least expensive. In 2021, natural gas prices once again continued to be lower than fuel oil prices. As a result, natural gas was used to meet over 99 percent of the heating

and cooling needs of the Laboratory's major facilities. Given the price disparity between natural gas and oil, the Laboratory will continue to purchase natural gas over oil, further reducing greenhouse gas (GHG) emissions. Additional information on natural gas and fuel oil use can be found in Chapter 4.

BNL continues to participate in available electric load reduction curtailment programs when available. Through these programs, the Laboratory agrees to reduce electrical demand during critical days throughout the summer when New York Independent System Operator expects customer demand to meet or exceed the available supply. In return, BNL sometimes receives a rebate for each megawatt reduced on each curtailment day. The Laboratory strives to keep electric loads at a minimum during the summer by scheduling operations at the Relativistic Heavy Ion Collider to avoid peak demand periods. This scheduling reduces the electric demand by approximately 25 megawatts (MW), saving approximately \$1.4 million in electric demand costs and helping to maintain the reliability of the Long Island Power Authority (LIPA) electric system to meet all its users' needs. BNL also maintains a contract with the New York Power Authority that resulted in an overall cost avoidance of \$26.5 million for 2021.

In 2021, BNL's energy supply included 120 million kWh of clean, renewable hydropower energy, 1.0 million kWh of on-site generated solar photovoltaic (PV), and 24 million kWh of purchased renewable energy certificates (REC). The Laboratory will continue to seek alternative energy sources to meet its future energy needs, support federally required "green" initiatives, and reduce energy costs.

In 2011, BP Solar completed construction of the Long Island Solar Farm (LISF) on BNL property. The array is one of the largest solar PV arrays (32 MW) in the Northeast and spans 195 acres with more than 164,000 panels. BNL worked extensively with LIPA, BP Solar, the State of New York, and other organizations to evaluate the site and develop the project, with LIPA purchasing the output through a 20-year Power Purchase Contract.

The annual output for 2021 was 48.9 million kWh and resulted in an avoidance of approximately 27,055 metric tons CO₂ equivalents (MT

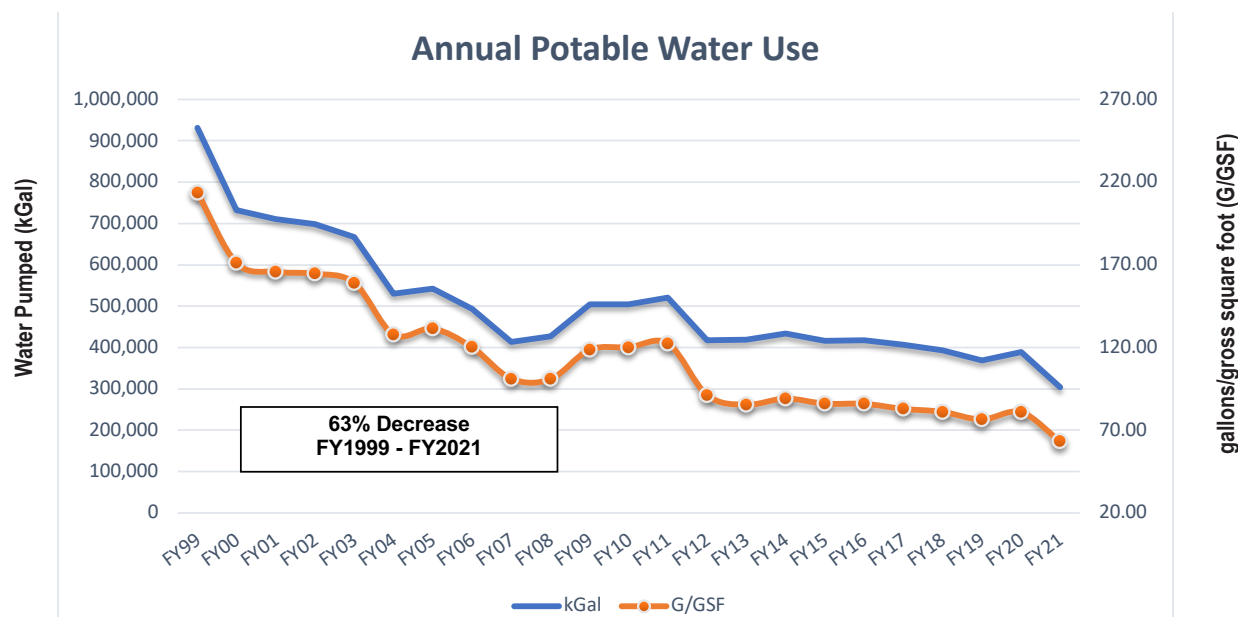


Figure 2-2. Annual Potable Water Use, 1999-2021.

CO₂e) GHG offset or reduction. At the time of the installation, the estimated annual output was 44 million kWh. The actual output for the first nine operational years was an average of 50.1 million kWh/year, substantially above the estimated annual average value. As an outcome of constructing this large array on site, the Laboratory has developed a solar research program that looks at impacts of climate change on large utility-scale PV systems, as well as research and development for solar power storage and inverter efficiencies. The Federal Energy Management Program recognizes the importance of the efforts of BNL and the DOE Brookhaven Site Office to host the LISF and provides credit toward BNL's SSP renewable energy goal.

In May 2015, the Laboratory completed the installation of the first phase of the solar PV research array as part of the Northeast Solar Energy Research Center (NSERC). In 2016, the array was increased to 816 kW with substantial funding assistance from the Sustainability Performance Office (SPO). In 2021, the NSERC generated 659,336 kWh of electricity for use on site offsetting 365 MT CO₂e.

To reduce energy use and costs at non-research facilities, several activities were continued or undertaken by the BNL Energy Management

Group in 2021:

- *NYPA Power Contract*: Tenth full year of a ten-year contract with provision to extend up to 15 years that includes 15 MW of renewable (nearly zero greenhouse gas [GHG]) hydropower. This contract saved \$26.6 million in 2021.
- *DOE Sustainability Initiative*: The Energy Management Group continues to provide substantial support to the Federal/DOE-wide Sustainability Initiative and has created a BNL Sustainability Leadership Team. The team has developed a formal site-wide sustainability program beyond DOE requirements, participates in one of three subcommittees for DOE on sustainability initiatives, and provides numerous evaluations and estimates on energy use, GHG, renewable energy, and energy-efficiency options.
- *Continued progress occurred on several initiatives included in BNL's annual SSP in 2021, such as the following*: New electric, chilled water, and steam meter installations; funding for energy conservation initiatives; the purchase of RECs in meeting BNL's SSP goal; and training various parties on energy conservation initiatives.
- *Utility Energy Services Contract (UESC)*: A



Northeast Solar Energy Research Center (NSERC)



View of the Northeast Solar Energy Research Center (NSERC)

UESC contract/project was completed in 2015 with the National Grid which installed energy-efficient lighting, new building controls, and an energy-efficient water chiller. The environmental benefits of this UESC were estimated to include electrical savings of 3,549,114 kWh/year, fuel savings of 89,541 mm British thermal units (Btu)/year, a GHG reduction of 7,022 MT-CO₂e, and a building energy intensity reduction of 11 percent. To date, actual energy savings meet or exceed the original estimates. Through a comprehensive Measurement and Verification process, BNL has been able to verify that actual energy savings were within a few percent of the original projections for five years of operation.

- *UESC II:* BNL completed an Investment Grade Audit (IGA) for a potential second UESC effort. The IGA identified several projects that will reduce BNL's deferred maintenance backlog while reducing energy intensity and GHG's. A contract for the second UESC project was expected to be awarded in 2020. However, due to some technical and financial issues, the effort has been put on

hold. BNL is evaluating other options.

- *Energy Conservation:* Energy and water evaluations are completed for 25 percent of the site each year. Cost-effective projects are identified and proposed for funding, as appropriate.
- *High Performance Sustainability Buildings (HPSB):* Substantial completion of various energy and water conservation projects has achieved compliance in the EPA Portfolio Manager program. BNL is currently on target to meet or exceed the HPSB goal.
- *Renewable Energy:* Project support continues for the LISF and NSERC facilities and annual purchases of REC's to meet targeted goals.
- *The Central Chilled Water Facility (CCWF):* The CCWF continues to utilize a 3.2-million-gallon chilled water storage tank to reduce peak electric demand by producing and storing chilled water during the night.
- *Natural Gas Purchase Contract:* BNL is currently saving over \$2 million per year using natural gas compared to oil.
- *Energy Savings:* As mentioned above, 25 MW of demand is rescheduled each year to avoid coinciding with the utility summer peak, saving over \$1.4 million in electricity charges. In addition, work continues in the replacement of aging, inefficient T-40 fluorescent lighting fixtures with new, high-efficiency T-8 lighting fixtures and/or LED fixtures as appropriate. Typically, 200 to 300 fixtures are replaced annually, saving tens of thousands of kWhs each year and reducing costs by several thousand dollars. Due to continued conservation efforts, overall facilities energy usage for 2021 was approximately 25.2 percent less than in 2003, producing annual savings of \$2.2 million.

The National Energy Conservation Policy Act, as amended by the Federal Energy Management Improvement Act of 1988 and the Energy Policy Acts of 1992 and 2005, as well as the Energy Independence and Security Act of 2007, requires federal agencies to apply energy conservation measures and improve federal building design to reduce energy consumption per square foot (Energy Intensity). A current goal of EO 138434 is to reduce energy consumption per square foot, relative to 2015, by 25 percent by the year 2025.

As shown in Figure 2-3, BNL's energy use per square foot in 2021 was 25.2 percent less than in FY 2003. It is important to note that energy use for most buildings and facilities at the Laboratory is largely weather dependent. Further, after decades of various energy conservation measures nearly all the cost-effective measures have been implemented. Regardless, BNL will continue to strive to meet the energy intensity reduction goals. In 2021, energy intensity was 0.1 percent less than the base year of 2015, which was less than previous years due to a change in how the NSERC electricity production was factored into BNL's energy consumption.

2.3.4.7 Natural and Cultural Resource Management Programs

Through its Natural Resource Management Plan (BNL 2021), BNL continues to enhance its Natural Resource Management Program for the Lab and the Upton Ecological and Research Reserve. The Laboratory also continues to enhance its Cultural Resource Management Program. A BNL Cultural Resource Management Plan (BNL 2013a) was developed to identify and manage properties that are determined to be eligible for inclusion on the National Register of Historic Places. See Chapter 6 for further information about these programs.

2.3.4.8 Environmental Restoration

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly known as Superfund, was enacted by Congress in 1980. As part of CERCLA, EPA established the National Priorities List, which identifies sites where cleanup of past contamination is required. BNL was placed on the list with 27 other Long Island sites, 12 of which are in Suffolk County. Each step of the CERCLA cleanup process is reviewed and approved by DOE, EPA, and NYSDEC, under an Interagency Agreement (IAG). This agreement was formalized in 1992. Although not formal signatories of the IAG, the New York State Department of Health (NYSDOH) and the Suffolk County Department of Health Services (SCDHS) also play key roles in the review process.

Most of the contamination at the Laboratory is associated with past accidental spills and outmoded practices for handling, storing, and

disposing of chemical and radiological material. BNL follows the CERCLA process, which includes the following steps:

- Conduct a remedial investigation to characterize the nature and extent of contamination and assess the associated risks;
- Prepare a feasibility study and proposed plan to identify and evaluate remedial action alternatives and present the proposed alternative;
- Issue a Record of Decision (ROD), which is the corrective action agreed to by DOE, EPA, and NYSDEC;
- Perform the Remedial Design/Remedial Action, which includes final design, construction specifications, and carrying out the corrective action selected; and
- Removal actions (time critical or non-time critical) are also performed under the CERCLA process.

In 2021, BNL's eight active groundwater treatment systems removed approximately 58 pounds of volatile organic compounds (VOCs) and 0.34 millicurie (mCi) of strontium-90 (Sr-90) and returned one billion gallons of treated water to the sole source aquifer. In early 2021, BNL proposed to the regulatory agencies the addition of new Areas of Concern 33 (PFOS and PFOA) and 34 (1,4-Dioxane). Groundwater characterization data identified the need to modify the OU VI ethylene dibromide treatment system with additional extraction wells to capture deeper contamination. In accordance with a CERCLA Action Memorandum to conduct a Time Critical Removal Action, construction of two groundwater treatment systems to address PFAS contamination from the former and current firehouse source areas was initiated in July. Temporary wells were installed to characterize a firefighter training area west of Building 170 for PFAS, resulting in the identification of new sub-AOC 33J.

These groundwater systems are operated in accordance with Operations and Maintenance manuals. Institutional controls were also monitored and maintained for the cleanup areas in accordance with the RODs to help ensure the remedies remain protective of human health and the environment. An annual evaluation of these controls was submitted to the regulatory agencies. Table 2-3 provides a description of each Operable Unit and a

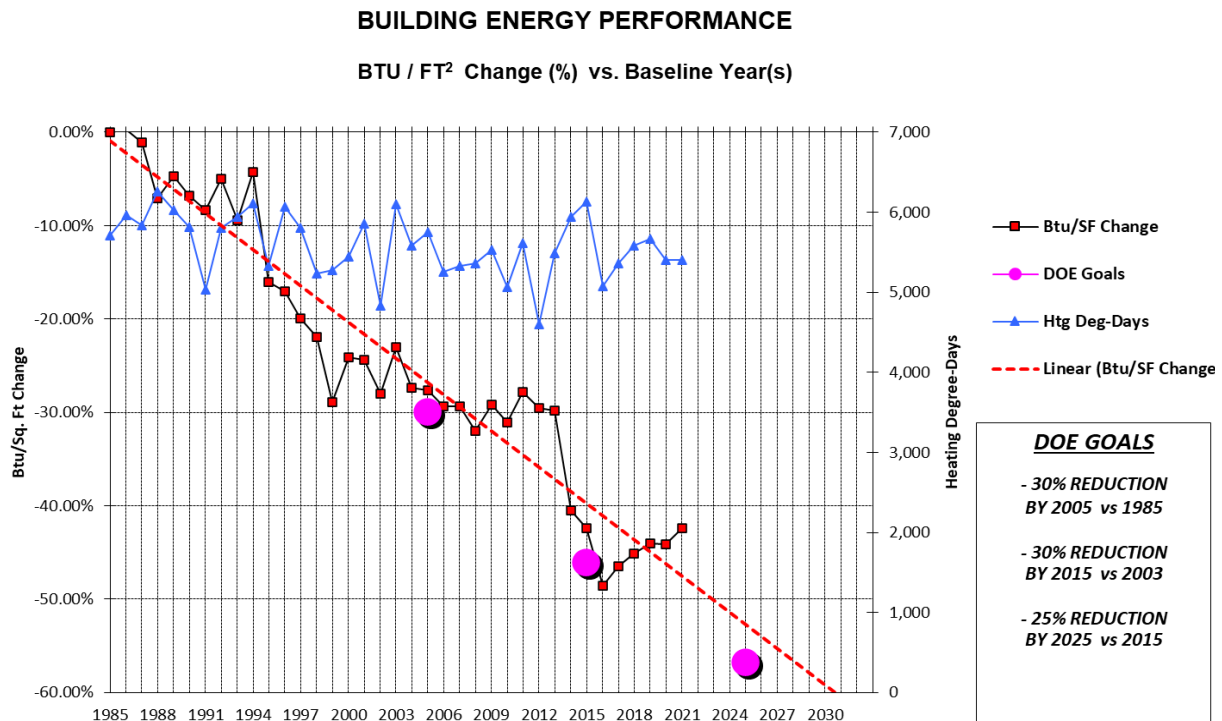


Figure 2-3. BNL Building Energy Performance for 2021 (Btu/SF Change Percent vs. Baseline Years).

summary of environmental restoration actions taken. See Chapter 7 and SER Volume II, Groundwater Status Report, for further details. In 2021, BNL continued the surveillance and maintenance of the Brookhaven Graphite Research Reactor (BGRR) and the HFBR. Demolition of the HFBR stack was completed in February, followed by soil and below ground structure removal and a final status survey. All waste was disposed of off-site and the contractor demobilized from the site in January 2022.

2.4 IMPLEMENTING THE ENVIRONMENTAL MANAGEMENT SYSTEM

2.4.1 Structure and Responsibility

All employees at BNL have clearly defined roles and responsibilities in key areas, including environmental protection. Supervisors are required to work with their employees to develop and document Roles, Responsibilities, Accountabilities, and Authorities (R2A2). BSA has clearly defined expectations for management and staff which must be included in the R2A2 document. Under the BSA performance-based management

model, senior managers must communicate their expectation that all line managers and staff take full responsibility for their actions and be held accountable for ESSH performance. Environmental and waste management technical support personnel assist the line organizations with identifying and carrying out their environmental responsibilities. Environmental Compliance Representatives (ECRs) are deployed to organizations throughout the Laboratory as an effective means of integrating environmental planning and sustainability into the work planning processes of the line organizations. A comprehensive training program for staff, visiting scientists, and contractor personnel is also in place, thus ensuring that all personnel are aware of their ESSH responsibilities.

2.4.2 Communication and Community Involvement

In support of BNL's commitment to open communication and community involvement, the Stakeholder and Community Relations (SCR) Office develops best-in-class communications,

Table 2-3. Summary of BNL 2021 Environmental Restoration Activities.

Project	Description	Environmental Restoration Actions
Soil Projects	Operable Unit (OU) I/II/III/VII	<ul style="list-style-type: none"> Performed inspections, monitoring, and maintenance of institutional controls for cleanup areas.
Groundwater Projects	OU III/V/VI	<ul style="list-style-type: none"> Continued operation of seven groundwater treatment systems that remove volatile organic compounds (VOCs) and one system that removes strontium-90 (Sr-90). Removed 58 pounds of VOCs and 0.3 mCi of Sr-90 during the treatment of 1.0 billion gallons of groundwater. Since the first groundwater treatment system started operating in December 1996, approximately 7,760 pounds of VOCs and 34 mCi of Sr-90 have been removed, while treating approximately 30 billion gallons of groundwater. Collected and analyzed approximately 1,122 sets of groundwater samples from 491 monitoring wells. Installed 70 temporary wells and collected multiple samples from each location. Installed temporary and permanent groundwater wells to characterize the ethylene dibromide identified in the deeper portion of the aquifer in the OU VI plume. The data indicates the need to modify the existing treatment system with additional extraction wells.
	OU VIII (PFOS/PFOA/1,4-Dioxane)	<ul style="list-style-type: none"> New Areas of Concern (AOC) 33 (PFOS and PFOA) and 34 (1,4-Dioxane) established in early 2021. Characterized a PFAS plume originating from a previously unknown firefighter training area west of Building 170. Temporary and permanent wells were used to characterized low levels of PFAS in the southwestern portion of the BNL site that is within the source water contributing area for the Suffolk County Water Authority William Floyd Wellfield. An Action Memorandum to conduct a time-critical removal action was approved in August to address PFAS contamination from the former and current firehouse source areas. Began construction of two PFAS groundwater treatment systems in July downgradient of the current and former firehouse facilities.
Peconic River	OU V	<ul style="list-style-type: none"> A population survey of fish in the on-site portion of the Peconic River was performed under BNL's Environmental Surveillance Program. An insufficient number of fish were identified to support sampling.
Reactors	Brookhaven Graphite Research Reactor (BGRR)	<ul style="list-style-type: none"> Continued long-term surveillance and maintenance, including sealing of cracks in the engineered cap, replacement of the leak detection sensor in the south cooler in the below ground ducts, repair to a hole in the rollup door on the west side of Building 701, and replaced a section of soffit and several sections of the siding on one of the protective covers.
	High Flux Beam Reactor (HFBR)	<ul style="list-style-type: none"> Continued long-term surveillance and maintenance, including removal of several small areas of potential asbestos on the floor, as well as posting these and several other areas indicating that there is a potential for Asbestos Containing Material, repair to the cracks and holes above the generator room door, and collection and disposal of stack paint chips on the ground outside the stack construction zone.
	Stack (Building 705)	<ul style="list-style-type: none"> Demolition of the stack was completed in February, followed by soil and below ground structure removal, and a final status survey. All waste was disposed of off-site, and the contractor demobilized from the site in January 2022. The draft Stack Closeout Report was submitted to the regulators for review in December.
	Brookhaven Medical Research Reactor (BMRR)	<ul style="list-style-type: none"> Continued surveillance and maintenance activities.
Former Buildings 810/811	Former Radiological Liquid Processing Facility	<ul style="list-style-type: none"> Maintained institutional controls of the area.
Building 801	Inactive Radiological Liquid Holdup Facility	<ul style="list-style-type: none"> Performed routine surveillance and maintenance of the facility.
Building 650	Inactive Radiological Decon Facility	<ul style="list-style-type: none"> Completed demolition of the facility, performed as-left survey and all waste disposed of off-site by July.

science education, government relations, and community involvement programs that advance the science and science education missions of the Laboratory. SCR contributes to the public's understanding of science, enhances the value of the Laboratory as a community, and ensures that internal and external stakeholders are properly informed and have a voice in decisions of interest and importance to them. SCR also works to maintain relationships with BNL employees and external stakeholders, such as neighbors, business leaders, elected officials, and regulators to provide an understanding of the Laboratory's science and operations, including environmental stewardship and restoration activities, and to incorporate community input into BNL's decision-making process.

To facilitate stakeholder input, SCR's Stakeholder Relations Office, in coordination with the EPD, participates in or conducts on- and off-site meetings which include discussions, presentations, roundtables, and workshops. Stakeholder Relations and EPD staff attend local civic association meetings, canvass surrounding neighborhoods, conduct Laboratory tours, and coordinate informal information sessions and formal public meetings, which are held during public comment periods for environmental projects.

BNL's Internal Communications Office manages programs to increase internal stakeholder awareness, understanding, and support of Laboratory initiatives; fosters two-way communications; and updates internal stakeholders on BNL priorities, news, programs, and events.

The SCR's Office of Educational Programs manages various education initiatives and programs that support the scientific mission at BNL and the DOE. Programs include Summer Science Explorations for grades four through 12, the Science Learning Center, internships, contests in science, technology, engineering, math, and postdoctoral programs.

2.4.2.1 Communication Forums

To create opportunities for effective dialogue between the Laboratory and its stakeholders, several forums for communication and involvement have been established, such as the following:

- The Brookhaven Executive Roundtable (BER), established in 1997 by DOE's

Brookhaven Site Office, meets routinely to update local, state, and federal elected officials and their staff, regulators, and other government agencies on environmental and operational issues, as well as scientific discoveries and initiatives.

- The Community Advisory Council (CAC), established by BNL in 1998, advises Laboratory management primarily on environmental, health, and safety issues related to BNL that are of importance to the community. The CAC is comprised of 26 member organizations and individuals representing civic, education, employee, community, environmental, business, and health interests. The CAC sets its own agenda in cooperation with the Laboratory meeting six months a year. The CAC is one of the primary ways the Laboratory keeps the community informed. Meetings are open to the public and are announced on the BNL homepage calendar and on the Stakeholder Relations website which links to the CAC webpage, meeting agendas, and past meeting presentations and minutes. An opportunity for public comment is provided at each meeting. Organizations interested in participating on the CAC are encouraged to attend meetings and make their interest known.
- Monthly teleconference calls are held with parties to the Laboratory's Interagency Agreement and other federal, state, and local regulators to update them on project status. The calls also provide the opportunity to gather input and feedback and to discuss emerging environmental findings and initiatives.
- Stakeholder Relations also manages several outreach programs that provide opportunities for stakeholders to become familiar with the Laboratory's facilities and research projects. Outreach programs include:
 - *Tour Program:* Opportunities to learn about BNL are offered to college, university, professional, and community groups. Tour groups visit the Laboratory's scientific machines and research facilities and meet with scientists to discuss research. Agendas are developed to meet the interests of the groups and may include sustainability and environmental stewardship issues. Tours

were provided for more than 2,500 visitors in 2019. However, due to the COVID-19 pandemic, tours were limited or not permitted in 2020 and 2021.

- *Summer Sundays:* Held on four Sundays each summer, these open houses enable the public to visit BNL science facilities, experience hands-on activities, and learn about research projects and environmental stewardship programs. In 2019, more than 4,700 visitors participated in the program. However, due to the continued COVID-19 pandemic, Summer Sundays was offered only virtually in 2021.

The Laboratory also participates in and hosts various outreach events throughout the year such as festivals, workshops, BNL's Earth Day celebration, the World Science Festival, the City of Science, the New York City Maker Faire, and the Port Jefferson Mini-Maker Faire. Brown bag lunch meetings for employees are held periodically and cover topics of interest, including project updates, newly proposed initiatives, wildlife management concerns, updates regarding COVID-19, and employee benefits information. However, these types of outreach events were limited in 2021 due to the COVID-19 pandemic.

BNL's Media & Communications Office issues press releases to news and media outlets and the Internal Communications Office publishes electronic and printed weekly employee newsletters, such as Brookhaven This Week and The Brookhaven Digest. In addition, a Director's Office web-based publication, Monday Memo, is issued bi-weekly to employees and focuses on topics important to the Laboratory population.

The Laboratory maintains an informative website at www.bnl.gov, where these publications, as well as extensive information about BNL's science and operations, past and present, are posted. In addition, employees and the community can subscribe to the Laboratory's e-mail news service.

Community members can ask questions or comments by clicking on the "Let us know" link found under "Listening to you" on the Stakeholder Relations website at www.bnl.gov/stakeholder/. Community members can also subscribe to the weekly e-newsletter, Brookhaven This Week, found on the Media Communications webpage at www.bnl.gov/, which keeps Lab employees and

the community informed about happenings at BNL, explains some of the science behind Laboratory research, and invites subscribers to educational and cultural events.

The COVID-19 pandemic did not stop BNL from proactively communicating with its internal and external stakeholders through many virtual platforms during 2021. Monthly interagency calls were held and, as stated above, all of the traditional Summer Sunday open house forums were held virtually. Additionally, all regularly scheduled Community Advisory Committee and Brookhaven Executive Roundtable meetings were held virtually to ensure continued and timely communication with the community.

2.4.2.2 *Community Involvement in Cleanup Projects*

In 2021, BNL updated stakeholders virtually on the progress of environmental cleanup projects, additional initiatives, and health and safety issues via mailings, briefings, and presentations given at CAC and BER meetings. These topics included the following:

- *Climate and Energy Research:* The CAC was informed about a field study in a coastal-urban environment, as well as exciting developments in the field of climate research and energy storage.
- *Actinium-225:* The CAC learned about High Energy Accelerator Production of the medical isotope Actinium-225.
- *Electron Ion Collider:* The CAC received updates about the timeline, approval process, infrastructure, and science that will be necessary for the construction and operation of the Electron Ion Collider (EIC), a particle accelerator that will collide electrons with protons and nuclei to produce snapshots of those particles' internal structure. EIC research will spark innovation and enable widespread technological advances.
- *Natural & Cultural Resources:* The CAC received updates on BNL's natural resources, such as the status of flora and fauna on site, Cesium-137 in deer, terrestrial vegetation, and soil. However, the COVID-19 pandemic caused cancellation of most the Natural Resources Program in 2021.

- *Environmental Updates:* In 2021, the CAC also received environmental updates such as the general status of the groundwater contaminant plumes and remediation systems; updates on the demolition and decommissioning of the High Flux Beam Reactor (HFBR) Stack; updates on emerging contaminants PFAS and 1,4 Dioxane in groundwater and proposed NYS drinking water standards for these contaminants; as well as national emission standards for hazardous air pollutants.

2.4.3 Monitoring and Measurement

DOE Order 436.1 requires DOE sites to maintain an EMS which conforms to the ISO14001 Standard for Environmental Management Systems. BNL's EMS specifies requirements for conducting general surveillance to determine impact from site operations to the environment. DOE Order 458.1 Admin Chg 4, (2020), Radiation Protection of the Public and Environment, requires DOE sites to maintain surveillance monitoring for determining radiological impacts, if any, to the public and environment from site operations.

BNL's EMS includes an Environmental Monitoring Program (EMP) which is a comprehensive,

site-wide program that identifies potential pathways for exposure of the public and employees, evaluates the impact activities have on the environment, and ensures compliance with environmental permit requirements. The EMP defines how the Laboratory will monitor effluents and emissions to ensure the effectiveness of controls, adherence to regulatory requirements, and timely identification and implementation of corrective measures. The plan uses the EPA Data Quality Objective approach for documenting the decisions associated with the monitoring program. In addition to the required triennial update, an annual electronic update is also prepared. The monitoring programs are reviewed and revised, as necessary, to reflect changes in permit requirements, changes in facility-specific monitoring activities, or the need to increase or decrease monitoring based on a review of previous analytical results.

As shown in Table 2-4, in 2021, there were 5,272 sampling events of groundwater, potable water, precipitation, air, plants and animals, soil, sediment, and discharges under the Environmental Monitoring Program. Specific sampling programs for the various media are described further in Chapters 3 through 8.

Table 2-4. Summary of BNL Sampling Program Sorted by Media, 2021.

Environmental Media	No. of Sampling Events(a)	Purpose
Groundwater	1209	Groundwater is monitored to evaluate impacts from past and present operations on groundwater quality under the Environmental Restoration, Environmental Surveillance, and Compliance sampling programs. See Chapter 7 and SER Volume II, Groundwater Status Report, for further detail.
On-Site Recharge Basins	50	Recharge basins used for wastewater and stormwater disposal are monitored in accordance with discharge permit requirements and for environmental surveillance purposes. See Chapter 5 for further detail.
Potable Water	26 C	Potable water wells and the BNL distribution system are monitored routinely for chemical and radiological parameters to ensure compliance with Safe Drinking Water Act requirements. In addition, samples are collected under the Environmental Surveillance Program to ensure the source of the Laboratory's potable water is not impacted by contamination. See Chapters 3 and 7 for further detail.
Sewage Treatment Plant (STP)	110	The STP influent and effluent and several upstream and downstream Peconic River stations are monitored routinely for organic, inorganic, and radiological parameters to assess BNL impacts. The number of samples taken depends on flow. For example, samples are scheduled for collection at Station HQ monthly, but if there is no flow, no sample can be collected. See Chapters 3 and 5 for further detail.
Precipitation	8	Precipitation samples are collected from two locations to determine levels of mercury present in rain to support long-term monitoring of atmospheric disposition of mercury.
Air – Tritium	214	Silica gel cartridges are used to collect atmospheric moisture for subsequent tritium analysis. These data are used to assess environmental tritium levels. See Chapter 4 for further detail.

(continued on next page)

Table 2-4. Summary of BNL Sampling Program Sorted by Media, 2021 *(concluded)*.

Environmental Media	No. of Sampling Events(a)	Purpose
Air – Particulate	323 ES/C 52 NYSDOH	Samples are collected to assess impacts from BNL operations and to facilitate reporting of emissions to regulatory agencies. Samples are also collected for the New York State Department of Health Services as part of their program to assess radiological air concentrations statewide. See Chapter 4 for further detail.
Fauna	93	Fish and deer are monitored to assess impacts on wildlife associated with past or current BNL operations. See Chapter 6 for further detail.
Flora	10	Vegetation is sampled to assess possible uptake of contaminants by plants and fauna, since the primary pathway from soil contamination to fauna is via ingestion. See Chapter 6 for further detail.
Soils	10	Soil samples are collected as part of the Natural Resource Management Program to assess faunal uptake, during Environmental Restoration investigative work, during the closure of dry-wells and underground tanks, and as part of preconstruction background sampling.
Miscellaneous	411	Samples are collected periodically from potable water fixtures and dispensers, manholes, and spills to assess process waters and to assess sanitary discharges.
Groundwater Treatment Systems Monitoring	948	Samples are collected from groundwater treatment systems operated under the Comprehensive Environmental Response, Compensation, and Liability Act program. The Laboratory has eight operating groundwater treatment systems. See discussion in Chapter 7.
State Pollutant Discharge Elimination System (SPDES)	329	Samples are collected to ensure that the Laboratory complies with the requirements of the New York State Department of Environmental Conservation-issued SPDES permit. Samples are collected at the STP, recharge basins, and four process discharge sub-outfalls to the STP.
Flow Charts	583	Flowcharts are exchanged weekly as part of BNL's SPDES permit requirements to report discharge flow at the recharge basin outfalls.
Floating Petroleum Checks	96	Tests are performed on select petroleum storage facility monitoring wells to determine if floating petroleum products are present. The number of wells and frequency of testing is determined by NYSDEC licensing requirements (e.g., Major Petroleum Facility), NYSDEC spill response requirements (e.g., Motor Pool area), or other facility-specific sampling and analysis plans.
Radiological Monitor Checks	498	Daily instrumentation checks are conducted on the radiation monitors located in Buildings 569 and 592. These monitors are located 30 minutes upstream and at the STP. Monitoring at these locations allows for diversion of wastes containing radionuclides before they are discharged to the Sewage Treatment Plant recharge basins.
Quality Assurance/Quality Control Samples (QA/QC)	302	To ensure that the concentrations of contaminants reported in the Site Environmental Report are accurate, additional samples are collected. These samples detect if contaminants are introduced during sampling, transportation, or analysis of the samples. QA/QC samples are also sent to the contract analytical laboratories to ensure their processes give valid, reproducible results.
Total number of sampling events	5,272	The total number of sampling events includes all samples identified in the Environmental Monitoring Plan (BNL 2021), as well as samples collected to monitor Environmental Restoration (CERCLA) projects, air and water treatment system processes, and by the Environmental Protection Division Field Sampling Team as special requests. The number does not include samples taken by Waste Management personnel, waste generators, or Environmental Compliance Representatives for waste characterization purposes.

Notes:

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

C = Compliance

ES = Environmental Surveillance

The Environmental Monitoring Program addresses three components: compliance, restoration, and surveillance monitoring.

2.4.3.1 Compliance Monitoring

Compliance monitoring is conducted to ensure that wastewater effluents, air emissions, and groundwater quality comply with regulatory and permit limits issued under the federal Clean Air Act, Clean Water Act, Oil Pollution Act, SDWA, and the New York State equivalents.

Air emissions monitoring is conducted at reactors no longer in operation, accelerators, and other radiological emission sources, as well as the CSF. Real-time, continuous emission monitoring equipment is installed and maintained at some of these facilities, as required by permits and other regulations. At other facilities, samples are collected and analyzed periodically to ensure compliance with regulatory requirements. Analytical data are routinely reported to the permitting agencies. See Chapters 3 and 4 for details.

Wastewater monitoring is performed at the point of discharge to ensure that the effluent complies with release limits in the Laboratory's SPDES permits. Twenty-four point-source discharges are monitored—12 under BNL's SPDES Permit and nine under equivalency permits issued to the Environmental Restoration Program for groundwater treatment systems. As required by permit conditions, samples are collected daily, weekly, monthly, or quarterly, and monitored for organic, inorganic, and radiological parameters. Monthly discharge monitoring reports that provide analytical results and an assessment of compliance for that reporting period are filed with the NYSDEC. See Chapter 3, Section 3.6, for details.

Groundwater monitoring is performed to comply with regulatory operating permits. Specifically, monitoring of groundwater is required under the Major Petroleum Facility License for the CSF, the RCRA permit for the Waste Management Facility, and the SPDES permit for the Sewage Treatment Plant (STP). Extensive groundwater monitoring is also conducted under the CERCLA program (described in Section 2.4.3.2 below). Additionally, to ensure that the Laboratory maintains a safe drinking water supply, BNL's potable water supply is monitored as required by SDWA, which is administered by SCDHS.

2.4.3.2 Restoration Monitoring

The Environmental Restoration Program operates and maintains groundwater treatment systems to remediate contaminant plumes both on and off site. BNL maintains an extensive network of groundwater monitoring wells to verify the effectiveness of the remediation effort. Modifications to groundwater remediation systems are implemented, as necessary, based upon a continuous evaluation of monitoring data and system performance. Details on the Peconic River monitoring program are provided in Chapter 6, and details on groundwater monitoring and restoration program are provided in Chapter 7 and SER Volume II, Groundwater Status Report.

2.4.3.3 Surveillance Monitoring

Surveillance monitoring is performed, in addition to compliance monitoring, to assess potential environmental impacts that could result from routine facility operations. The BNL Surveillance Monitoring Program involves collecting samples of ambient air, surface water, groundwater, flora, fauna, and precipitation.

Samples are analyzed for organic, inorganic, and radiological contaminants. Additionally, data collected using thermoluminescent dosimeters (i.e., devices that measure radiation exposure) strategically positioned on- and off-site is routinely reviewed under this program. Control samples (also called background or reference samples) are collected on and off the site to compare Laboratory results to areas that could not have been affected by BNL operations.

The monitoring programs can be broken down further by the relevant law or requirement (e.g., Clean Air Act) and even further by specific environmental media and type of analysis. The results of monitoring and the analysis of the monitoring data are the subject of the remaining chapters of this report. Chapter 3 summarizes environmental requirements and compliance data, Chapters 4 through 8 give details on media-specific monitoring data and analysis, and Chapter 9 provides supporting information for understanding and validating the data shown in this report.

2.4.4 EMS Assessments

To periodically verify that the Laboratory's EMS is operating as intended, assessments are

conducted as part of BNL's Contractor Assurance Program. Self-assessment is the systematic evaluation of internal processes and performance. Two types of assessments are conducted: the ISO 14001 Standard conformance assessment and the regulatory compliance assessments.

The approach for the ISO14001 program self-assessment includes evaluating programs and processes within organizations that have environmental aspects to verify conformance to the ISO14001 Standard. The assessment is performed by qualified external assessors or BNL staff members who do not have line responsibility for the work processes involved. Progress toward achieving environmental objectives is monitored, as are event-related metrics to determine the overall effectiveness of the EMS. The assessment determines if there are Laboratory-wide issues that require attention, and facilitates the identification and communication of best management practices used in one part of the Laboratory that could improve performance in other parts of the Lab.

Compliance assessments are also performed by BNL staff members who do not have line responsibility for the work processes involved to ensure that operations are in compliance with Laboratory requirements that reflect external compliance requirements. These assessments verify the effectiveness and adequacy of management processes (including self-assessment programs) at the division, department, directorate, and Laboratory levels. Special investigations are conducted to identify the root causes of events and identify corrective actions and lessons learned if regulatory noncompliance or impact occurs to correct the problem and prevent reoccurrence.

BNL management routinely evaluates progress on key environmental improvement projects. The Laboratory and DOE periodically perform assessments to facilitate the efficiency of assessment activities and ensure that the approach to performing the assessments meets DOE expectations.

The Laboratory's Contractor Assurance Program is augmented by programmatic external audits conducted by DOE. BSA staff and subcontractors also perform periodic independent reviews, and an independent third-party conducts ISO 14001 registration audits of BNL's EMS. The Laboratory is

subject to extensive oversight by external regulatory agencies (see Chapter 3 for details). Results of all assessment activities related to environmental performance are included, as appropriate, throughout this report.

2.5 ENVIRONMENTAL STEWARDSHIP AT BNL

BNL has extensive knowledge of its potential environmental vulnerabilities and current operations due to ongoing process evaluations, the work planning and control system, and the management systems for groundwater protection, environmental restoration, and information management. Compliance assurance programs have improved the Laboratory's compliance status and pollution prevention projects have reduced costs, minimized waste generation, and reused and recycled significant quantities of materials. BNL is openly communicating with neighbors, regulators, employees, and other interested parties on environmental issues and progress. To maintain stakeholder trust, the Laboratory will continue to deliver on commitments and demonstrate improvements in environmental performance. The Site Environmental Report is an important communication mechanism, as it summarizes BNL's environmental programs and performance each year. New efforts to reduce carbon emissions as a means to addressing climate change impacts will be integrated into BNL's EMS in the future as directed by DOE as part of the Federal Sustainability Plan.

Additional information about the Laboratory's environmental programs is available on BNL's website at <http://www.bnl.gov>. BNL is often asked to share its experiences, lessons learned, and successes. The Laboratory's environmental programs and projects have been recognized with international, national, and regional awards, and audits have consistently observed a high level of management involvement, commitment, and support for environmental protection and the EMS.

For over 70 years, the unique, leading-edge research facilities and scientific staff at BNL have made many innovative scientific contributions possible. Today, BNL continues its research mission while focusing on cleaning up and protecting the environment.

CHAPTER 2: ENVIRONMENTAL MANAGEMENT SYSTEM

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