Environmental Management System

In 1999, Brookhaven National Laboratory continued to develop and implement an Environmental Management System to ensure that it operates in an environmentally responsible manner. The Laboratory's Environmental Management System is consistent with the International Standards Organization 14001 Standard, with increased emphasis in the areas of compliance assurance, pollution prevention, and community outreach. Compliance and environmental considerations are being integrated into the planning, decision-making, and implementation phases of all site activities. Organizational changes have been made to strengthen environmental programs.

The Facility Review Project has continued to define, prioritize, and remedy historical problems. Industrial and experimental processes onsite were evaluated for compliance and pollution prevention opportunities. An extensive program to monitor environmental quality is in place.

BNL now has an unprecedented level of knowledge of current operations and potential environmental vulnerabilities. Pollution prevention projects have saved more than $1,600,000 and resulted in the reduction or reuse of over 16,000,000 pounds of industrial and hazardous waste in 1999. The Relativistic Heavy Ion Collider facility was officially certified to the International Standards Organization 14001 Standard, becoming the first Long Island-based operation and the first DOE Office of Science facility to achieve this level of recognition. The Laboratory is openly communicating with neighbors, regulators, employees, and other interested parties on environmental issues and progress.

2.1 ENVIRONMENTAL STEWARDSHIP UNDER BROOKHAVEN SCIENCE ASSOCIATES (BSA)

BNL continues to develop and implement an Environmental Management System (EMS) under the new leadership of BSA. An EMS is a systematic methodology for managing the environmental aspects of an organization's operations. It is part of the Laboratory's overall management system that includes organizational structure, planning activities, responsibilities, practices, procedures, processes, and resources for developing, implementing, achieving, reviewing, and maintaining BNL's Environmental Stewardship Policy.

BNL has pursued a multi-pronged approach to address historical and current problems and to prevent future problems.

2.1.1 ORGANIZATIONAL CHANGES

One key to the success of this approach is leadership. When BSA assumed management of the BNL operating contract in March of 1998, they brought in several high-level managers, and a new Laboratory Director, Dr. John Marburger. Environmental protection and communication functions were formerly several layers down in the organizational structure. BSA created three new directorates that report directly to the Laboratory Director:

- *Community Involvement, Government and Public Affairs*. This directorate is responsible for coordinating internal and external communications, community relations, government relations, and museum programs.
- *Environment, Safety, Health and Quality*. Within this organization, a separate Environmental Services Division was established to integrate environmental protection programs.
- *Environmental Management*. This directorate includes a division that ensures the proper management of hazardous and radioactive waste and another division that provides for the cleanup of historical contamination onsite.

BNL also implemented an Environmental Compliance Representative program. These environmental professionals are deployed to the research and operational organizations full time. Embedding environmental professionals in the line organizations is improving compliance with environmental laws, regulations, and policy. The Environmental Compliance Representatives are currently tasked with supporting the process reviews described below, assisting in the development and implementation of the Environmental Management System within line organizations, and providing technical support to researchers and facility managers. Upon project completion, they will transition to sitewide technical support roles. In this capacity, they will help implement systems for continual improvement of environmental performance, with emphasis on pollution prevention.

Expectations for staff and management have been more clearly defined. In the past, as is often the case, responsibility for environment, safety and health had been relegated to the support organizations. Now, under the BSA management model, senior management has clearly communicated their expectation that all line managers are to take full responsibility for environment, safety, and health performance, and that line managers and staff will be held accountable. Every BNL employee was required to develop a Roles, Responsibilities, Accountabilities, and Authorities (R2A2) document signed by the employee, their supervisor, and the supervisor's manager. Specifics on environment, safety and health performance expectations are included in each employee's R2A2.

BSA also developed and funded a set of projects designed to integrate environmental stewardship into all facets of the Laboratory's missions. The managers selected for the projects have had the full support of upper management. Four of these key projects are described below.

2.1.2 ADDRESSING THE PAST: THE FACILITY REVIEW PROJECT

BNL has had an active Environmental Restoration Program onsite since 1989, when the site was placed on the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) National Priorities List (see description in section 2.6 below). However, after a tritium leak from the High Flux Beam Reactor spent fuel storage pool and strontium-90 contamination emanating from a sump at the inactive Brookhaven Graphic Research Reactor were discovered in 1997, BNL senior management realized that that an understanding of potential environmental vulnerabilities onsite was incomplete. To assess and address historical problems, BNL initiated the *Facility Review Project* in April of 1997. The Facilities Review Project was a comprehensive examination of all site facilities (existing or demolished)

to identify any past or current activities with the potential to degrade the environment. During this project, BNL reviewed the entire operating history of the site and more than 900 systems, facilities, and operations including tanks, pipes, sumps, cesspools, storage areas, historical discharges, and current and past operating practices. Twenty-eight individuals from fifteen other DOE facilities provided high-level support during the review.

Over 1,628 issues that had the potential to impact the environment were identified. BNL worked closely with the Suffolk County Department of Health Services to identify and prioritize the issues. The highest priority was assigned to issues with the potential to impact groundwater. The Laboratory is now in the process of further defining and remedying the problems. A database shared between BNL and Suffolk County tracks progress. The 75 highest priority issues that had the potential to have a negative impact on groundwater above drinking water standards are expected to be dispositioned (either closed out or integrated into another ongoing program) during 2000. In 2000, the Laboratory also expects to disposition approximately 45 percent of the other operational issues with the potential to impact groundwater to a lesser degree.

2.1.3 ADDRESSING THE PRESENT: THE PROCESS EVALUATION PROJECT

DOE signed a voluntary Memorandum of Agreement (MOA) with the U.S. Environmental Protection Agency (EPA) on March 23, 1998 (EPA/DOE 1998). One of the MOA requirements was "to evaluate all experimental and industrial-type operations at BNL for the purpose of identifying all waste streams produced at BNL" on a very aggressive schedule. All high priority processes were to be evaluated within one year, with the balance completed the following year. BNL realized that this effort could provide an unprecedented level of knowledge of operations, and form a strong technical basis for other environmental improvement programs. The scope was expanded by BNL and efforts were "projectized" into the *Process Evaluation Project*. A process mapping technique was used to develop flow diagrams showing all inputs and outputs (see Figure 2-1, an example of a process map for x-ray film developing operations). Process inputs are the materials used in a process. Process outputs are a multimedia evaluation of wastes, effluents, and air emissions produced in a process. A formal regulatory determination of all outputs (waste description, determination, and handling) was conducted. Pollution prevention opportunities

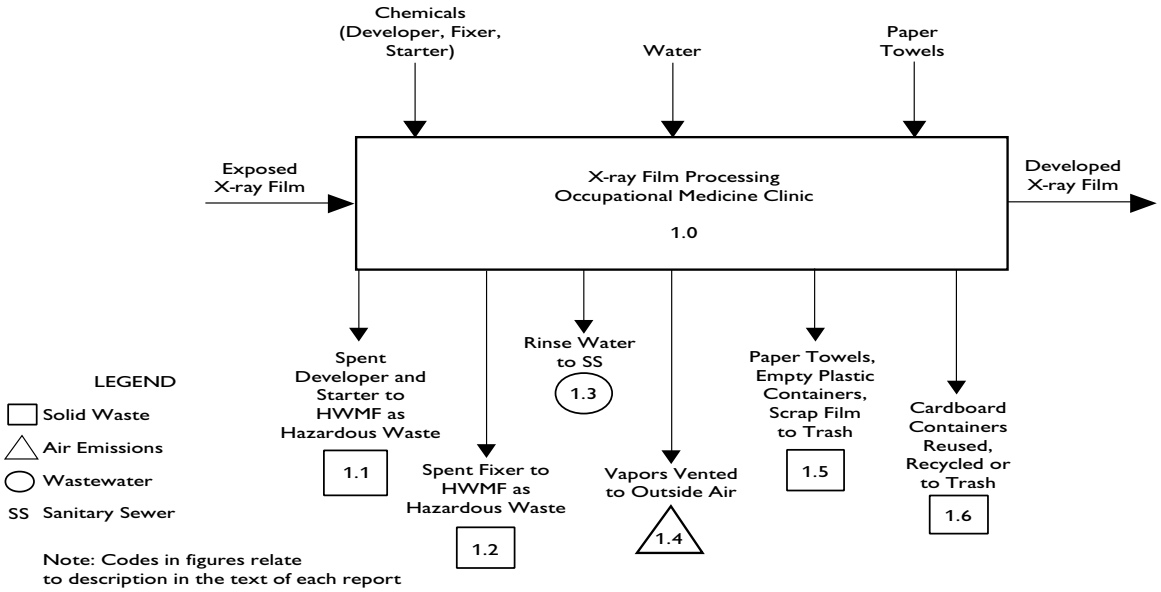


Figure 2-1. Sample Process Flow Diagram from Process Evaluation Project.

and best management practices were identified and are being evaluated. In total, over 145 industrial processes (e.g., machining, painting, electronics) and 1,821 research experiments were evaluated, ahead of the schedule established in the MOA. Approximately 170 corrective actions were identified and are being tracked to closure. Over 245 pollution prevention opportunities were identified, and all are being evaluated or have already been implemented. The approximate cost of $1,600,000 was borne by the line organizations (60 percent) and overhead funding (40 percent).

2.1.4 ADDRESSING THE FUTURE: THE ENVIRONMENTAL MANAGEMENT SYSTEM PROJECT

The MOA also required that BNL establish an Environmental Management System. BNL's EMS uses the International Standards Organization (ISO) 14001 as a model. ISO 14001 is a consensus standard developed by an international consortium of industry, government, and environmental groups. It identifies requirements for a system to

- define and prioritize what needs protection and how to do it;
- monitor, measure, and communicate what is done and how it is done; and
- continually improve approaches and systems for environmental protection.

The Laboratory's EMS is consistent with the international standard. Additionally, in response to EPA's concerns, there is increased emphasis in the areas of compliance assurance, pollution prevention and community outreach.

Again, BNL decided to go above and beyond what the Agreement and the DOE operating contract required, by electing to ultimately register to the ISO 14001 Standard, as opposed to self-declaring that they had a conforming system. Under the *Environmental Management System Project*, BNL is pursuing a phased approach, by first registering high profile, select facilities, and then seeking to register the entire Laboratory to the ISO 14001 Standard in 2001. The registration process involves rigorous audits by an American National Standards Institute Registrar Accreditation Board organization. The auditors evaluate BNL's conformance to the standard, whether the program is effectively implemented, and whether an effective assessment and corrective action program is in place. While the significance of ISO 14001 registration may not be as meaningful to the general public as it is to the environmental and regulatory community, BNL believes that it is important from a trust and credibility standpoint to undergo the independent, third party review. The ISO 14001 EMS is a valuable blueprint and registration is a recognized mechanism that the outside world can judge.

2.2 EMS IMPLEMENTATION

BNL has committed more than $2,700,000 to this three-year project. The goal of the project is to fundamentally and systematically change the way the Laboratory operates. The ultimate goal of the EMS is to ensure that Laboratory's programs are managed in an environmentally responsible manner that protects the ecosystem and human health.

Under the EMS project, existing systems were identified and are being enhanced, revamped and integrated. The 17 major elements of an ISO 14001 EMS are listed in Table 2-1, along with a summary of how BNL plans to satisfy each element. Figure 2-2 shows the relationship between program elements.

2.2.1 ENVIRONMENTAL STEWARDSHIP POLICY

During the first year of the EMS project (which was completed in July 1999), BNL developed institutional requirements. One of the early steps was developing and communicating an environmental policy (see Figure 1-4 in Chapter 1). The policy articulates high level commitments and is the cornerstone of BNL's EMS. This Environmental Stewardship policy is posted throughout the Laboratory and on the BNL website. A hard copy was also sent to all employees with a letter from the Laboratory Director, outlining his personal commitment to environmental protection and his expectation that all staff would participate in this way of doing business.

The Environmental Stewardship policy contains the following goals and commitments:

- Achieve and maintain compliance with applicable environmental requirements. These requirements include over 50 sets of local, state and federal laws, and regulations and approximately 60 operating permits.
- Integrate pollution prevention, waste minimization and resource conservation into Laboratory activities during the planning, decision-making, and implementation phases. Conserve natural resources. Ensure that environ-

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

Environmental Policy	BNL reaffirmed the commitments in its environmental policy: compliance, pollution prevention, cleanup, community outreach, and continual improvement. This policy is used as a framework for planning and action.
Environmental Aspects	BNL has determined that the following aspects of its operations have the potential to affect the environment: • Waste generation • Atmospheric emissions • Liquid effluents • Storage or use of chemicals and radioactive materials • Natural resource usage - power, water • Historical monuments/cultural resources • Environmental noise • Odors • Disturbances to endangered species/protected habitats • Soil activation • Historical contamination When operations at BNL have an environmental aspect, the organization implements an EMS to eliminate or minimize any potential impact. The elements of the EMS are described in this table.
Legal and Other Requirements	New or revised requirements (e.g. new regulations) are analyzed to determine their applicability to the Laboratory, and to determine whether actions are required to achieve compliance. This may involve developing or revising Laboratory documents, developing specific work instructions, administering training, installing engineered controls, or increasing monitoring.
Objectives and Targets	BNL establishes environmental objectives and performance measures to drive improvements to the EMS and environmental performance. They focus on the environmental aspects that can have a significant impact and/or reflect stakeholder concerns, and are aligned with commitments made in the environmental policy. The 1999 objectives and targets include: • Achieving excellent performance in environmental protection (e.g., minimal permit exceedances, spills, tritium releases) • Timely completion of key environmental improvement projects (e.g., Process Evaluation, EMS, Groundwater, Wildlife Management, Environmental Restoration) • Waste minimization and elimination of legacy wastes • Enhancing the responsiveness and effectiveness of Laboratory communications with stakeholders on environmental monitoring results.
Environmental Management Program	Organizations within BNL develop action plans detailing how they will achieve their objectives and targets, and commit the needed resources to successfully implement the plan. BNL also has a budgeting system designed to ensure that priorities are balanced, and that adequate resources are invested in environmental programs.
Structure and Responsibility	All employees at BNL have specific roles and responsibilities in key areas including environmental protection. The Assistant Laboratory Director for the Environment, Safety, Health and Quality Directorate leads the environmental protection efforts and is responsible for coordinating the implementation of the EMS within BNL and reporting on the performance to senior management. He utilizes the staff of the Environmental Services Division to accomplish this task.
Training and Awareness	BNL developed a comprehensive environmental training program in 1999, and initiated the training of staff, visitors, and contractors to ensure they are competent to carry out their environmental responsibilities. This training program includes general environmental awareness for all employees; regulatory compliance training for selected ES&H staff; and specific courses for managers, internal assessors, EMS implementation teams, and operations personnel whose work can impact the environment.
Communication	BNL continues to improve processes for internal and external communications on environmental issues. The Laboratoy seeks input from interested parties, such as community members, activists, civic organizations, elected officials and regulators, through a Citizens Advisory Committee and/or the Brookhaven Executive Roundtable.
EMS Documentation	A major initiative to develop and document Laboratory wide environmental requirements was completed. A web-based system called the Standards Based Management System (SBMS) provides access to regulatory requirements, Laboratory-wide procedures, and manuals that define for staff how to control processes and work performed at BNL in a way that protects the environment. SBMS has improved the quality, usability, and communication of Laboratory-level requirements.
Document Control	SBMS contains a comprehensive document control system to ensure effective management of procedures and other system records. When facilities require additional procedures to control their work, document control protocols are implemented to ensure that workers have access to the current versions of work instructions.

continued on next page

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

Operational Control	Through the Process Evaluation Project and EMS implementation, operations at the Laboratory are evaluated for adequacy of controls in preventing impacts to the environment. As needed, additional administrative or engineered controls are identified, and plans for upgrades and improvements are being developed.
Emergency Preparedness	BNL has a program to provide time critical response to hazardous materials or other environmental emergencies. This program includes procedures for preventing as well as responding to emergencies.
Monitoring and Measurement	Effluent and emission monitoring is important to ensure effectiveness of controls, adherence to regulatory requirements, and timely identification and implementation of corrective measures. BNL has a comprehensive, site-wide environmental monitoring program that results in an annual summary of its environmental performance in this Site Environmental Report and in reports to regulatory agencies. In addition, BNL tracks and trends its progress and performance in achieving its environmental objectives and performance measures.
Nonconformance and Corrective and Preventative Actions	BNL continues improving processes to identify and correct problems. This includes development of a lessons learned program to prevent recurrences and a robust self-assessment program.
Records	EMS-related records, including audit and training records, are maintained to ensure integrity, to protect them from loss, and to facilitate retrieval.
EMS Audit	Audits are conducted to periodically verify that the EMS is operating as intended. These audits, conducted as part of the sitewide self-assessment program, are designed to ensure that any nonconformance to the ISO 14001 Standard is identified and addressed. In addition, the Process Evaluation Project completed a regulatory compliance evaluation of all high priority processes in 1999, and initiated compliance evaluations of all remaining industrial operations and experiments onsite.
Management Review	In addition to audits, a management review process has been established to involve top management in the overall assessment of environmental performance, the EMS, and progress toward achieving its environmental goals. This review also identifies, as necessary, the need for changes and continual improvement of the EMS.

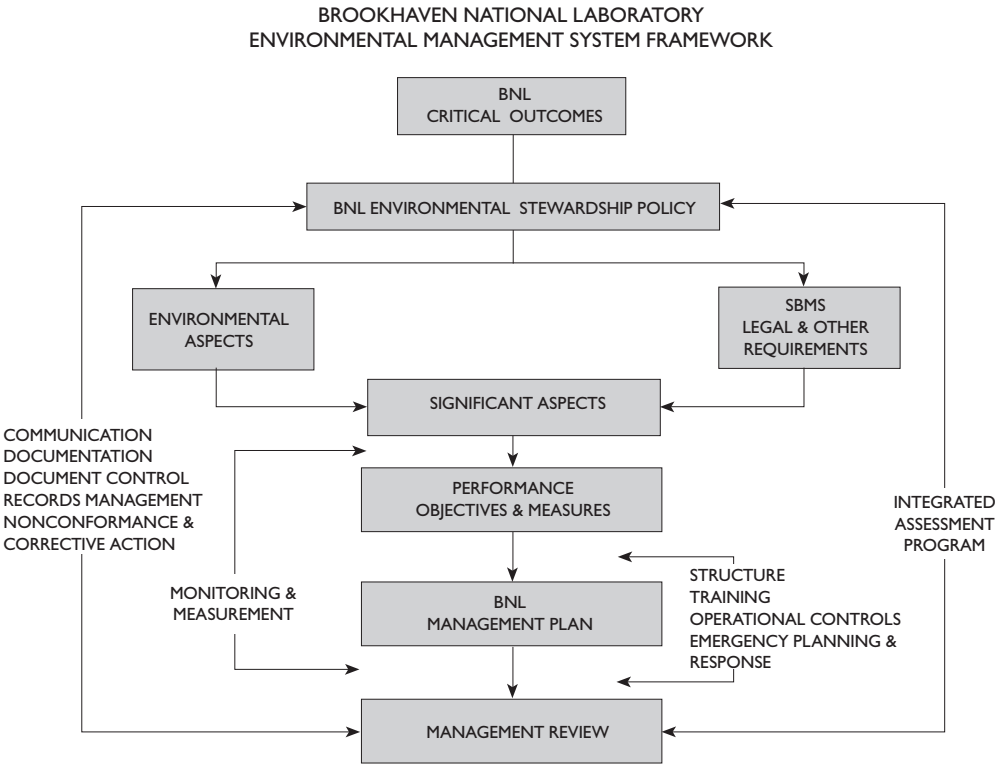


Figure 2-2. Key Elements of the BNL Environmental Management System.

mental emissions, effluents, and waste generation are As Low As Reasonably Achievable (a concept known as "Environmental-ALARA").
- Define, prioritize and remedy existing environmental problems. This commitment encompasses removal or treatment of contamination caused by historical practices, as well as strengthening the environmental monitoring program to ensure that controls designed to protect the environment are working and to provide early detection of a potential threat to the environment.
- Emphasize continual improvement. Employ proactive measures to prevent problems. When problems do occur, investigate the root cause and take corrective actions as appropriate.
- Openly communicate with neighbors, regulators, employees, and organizations about program progress and performance.

2.2.2 STANDARDS BASED MANAGEMENT SYSTEM (SBMS)

In order to implement the commitments in the policy, BNL improved on a tool called SBMS that had been developed by Pacific Northwest National Laboratory. SBMS is a web-based system designed to deliver requirements and guidance to all staff in a user-friendly format. All Labwide procedures reside in this system. The information provided focuses on what staff need to know to do their work in an environmentally responsible manner, and translates the requirements into plain English. Up-to-date "Subject Areas" were developed on 26 environmental topics. These Subject Areas were developed by teams of researchers and environmental protection professionals, with input from regulatory agencies. Figure 2-3 lists the environmental regulatory compliance and EMS-supporting Subject Areas. Existing standards for work and research planning and control were also upgraded to ensure that reviews by qualified ES&H staff occur early in the planning process, and that adequate measures to control hazards and risks are incorporated during the design phase.

2.2.3 PILOT FACILITIES

In 1999 the requirements described in section 2.2.2 were tested and validated in three pilot facilities. The facilities that volunteered to participate in the pilot phase of the EMS project implementation were the Relativistic Heavy Ion Collider (RHIC) Project, the Reactor Division, and Waste Management Program. Two of the three pilot facilities were independently verified as conforming to the ISO 14001 Standard by September 1, 1999. In 1999, the third pilot facility, RHIC, was officially certified to the ISO 14001 Standard by an independent accredited registrar, becoming the first Long Island-based operation and the first DOE Office of Science facility to achieve this level of recognition (see the certificate reproduced in Figure 2-4). After incorporating improvements recommended by

Titles of EMS Subject Areas

COMPLIANCE SUBJECT AREAS

Pollution Prevention and Waste Minimization
NEPA & Cultural Resource Evaluation
Environmental Monitoring
Non-radioactive Airborne Emissions
Radioactive Airborne Emissions
Drinking Water
Liquid Effluents
Underground Injection Control (UIC)
Storage and Transfer of Hazardous Materials
Oil/PCB Management
Hazardous Waste Management
Radioactive Waste Management
Mixed Waste Management
Regulated Medical Waste
Spill Response

EMS SUPPORT SUBJECT AREAS

Identification of Significant Environmental Aspects and Impacts
Environmental Evaluation of Industrial Processes & Experiments
Requirements Management
Requesting SBMS Variances
Correspondence and Commitment Tracking
Laboratory-wide Procedures and Guidelines Development
Internal, Controlled Documents
Calibration
Nonconformance and Corrective and Preventive Action
Records Management
Environmental Assessments

Figure 2-3. Environmental Management System Subject Areas in the Standards Based Management System.

NSF International Strategic Registrations, Ltd.

A Subsidiary of NSF International
2100 Commonwealth Boulevard, Suite 100, Ann Arbor, Michigan 48105
(888) NSF-9000

NSF-ISR

Certificate of Registration

This certifies that the Environmental Management System of

BROOKHAVEN NATIONAL LABORATORY

Corporate Address:
Building 1005 / P.O. Box 5000
Upton, NY 11973-5000
Phone: (516) 344-3465
Fax: (516) 282-7618
Contact: Ms. Susan L.K. Briggs

Site Address:
Relativistic Heavy Ion Collider
Building 1005 / P.O. Box 5000
Upton, NY 11973-5000

has been assessed by NSF-ISR and found to be compliant to the following standard(s):

ISO 14001:1996

Scope of Registration:
The scope of registration includes the Environmental Management System for the Relativistic Heavy Ion Collider (RHIC) Project (not all of BNL) operated by Brookhaven Science Associates and construction and commissioning of the Collider and Experiments. Also included are related activities encompassing superconducting magnet research & development, production of Collider magnets, and superconducting magnets for the Large Hadron Collider and other magnet R&D projects. Routine operation of the injector complex including the AGS Department and the U.S. Department of Energy are not included in the scope of this registration.

Industrial Classification:
SIC Code: 8999

NSF

Environmental Management System Registered to ISO 14001:1996

Authorized Registration and Accreditation Marks

Randy A. Dougherty, President, NSF - ISR

Certificate Number: 69521-E1
Certificate Issue Date: 08/25/99
Date of Initial Registration: 08/25/99

Figure 2-4. RHIC ISO 14001 Registration Certificate.

the pilots, the requirements were rolled out to the rest of the Laboratory. Deployment of the EMS throughout the balance of facilities at BNL began in July 1999 and is scheduled to be completed by October 2000. As noted above, BNL will pursue ISO 14001 certification at select organizations (Collider-Accelerator Department, Reactor Division, Brookhaven Linear Isotope Producer, Environmental Restoration Division and Waste Management Facility) and undergo an internal independent verification of conformance at the remaining facilities.

2.2.4 STAFF TRAINING AND AWARENESS

Extensive training on EMS program requirements was provided to staff whose responsibilities involved environmental protection. In total, almost 9,000 hours of environmental training were provided to staff from 1998-1999. All staff and visiting scientists working at BNL for more than two months are now required to take a computer-based training course developed by BNL to provide a basic level of environmental awareness. The course discusses the EMS, reviews the environmental requirements at a high level, and describes the impacts of non-compliance. Contractors and short-term visitors are also provided a modified training program covering the key points. Teams responsible for coordinating the implementation of the EMS within each organizational unit were provided in depth training on ISO 14001 requirements and techniques for effective implementation. To

support the Laboratory's Integrated Assessment Program (see section 2.3.2, below), select individuals were trained to perform EMS assessments. Finally, the top three levels of management were required to attend overview training on the EMS. In addition to training on EMS requirements, training sessions were conducted to introduce key staff to the environmental compliance requirements of the newly developed Subject Areas. This training was presented by subject matter experts from the BNL environmental protection program. It was an excellent opportunity to communicate the requirements to affected staff and answer questions on applicability and implementation.

2.3 EMS CONTINUAL IMPROVEMENT

BNL's EMS includes a commitment to continual improvement. The EMS is part of a sitewide integrated environment, safety and health system. It is interdependent with other management systems.

2.3.1 PERFORMANCE BASED MANAGEMENT SYSTEM

The Performance Based Management System is a method of developing, aligning, balancing and deploying Laboratory strategic objectives. The system drives the improvement agenda of BNL by establishing a prioritized set of incentivized performance objectives. Objectives include

- instituting mechanisms for assigning responsibility at all relevant levels of the organization, starting with senior management;
- implementing suggested actions for improvement;
- establishing clearly defined expectations and performance objectives; and
- routinely assessing progress against these objectives, in order to focus efforts and resources on relevant and important areas.

This approach helps employees understand how their work relates to Laboratory-level performance objectives so they can align their efforts toward achieving BNL missions. It also ensures that Laboratory operations are conducted in accordance with the expectations established by the Department of Energy and Laboratory management.

2.3.2 INTEGRATED ASSESSMENT PROGRAM

The Integrated Assessment Program was established to identify strengths and weaknesses in performance and areas for improvement. It is designed to contribute to and promote ongoing improvement in performance. The primary elements of BNL's Integrated Assessment Program are listed below.

- *Self-assessment* is the evaluation of internal processes and performance. The goal of a self-assessment program is to identify strengths and opportunities for improvement. The environmental portion of the self-assessment can include such items as assuring progress towards achieving performance goals. Examples include measuring progress on pollution prevention, or ensuring that operations are conducted in accordance with established requirements by auditing for environmental compliance. Under the self-assessment program, areas for improvement are identified and tracked to completion.
- *Peer Review* is a process to evaluate and independently verify the adequacy of engineering designs and operational controls, as well as the accuracy of documents.
- *Independent Oversight* is a mechanism to independently verify the effectiveness, efficiency and adequacy of the self-assessment programs. Special investigations are also conducted to identify the root causes of problems, corrective actions and lessons learned.
- *Internal Audit* is the process of examining and evaluating the adequacy and effectiveness of the BSA internal management controls. These audits focus on business systems.

The Integrated Assessment Program is augmented by programmatic, external audits conducted by DOE. In addition, corporate offices for Battelle Memorial Institute and BSA subcontractors perform periodic independent reviews. As noted above, ISO registration audits are conducted by an independent third party. BNL is also subject to extensive oversight by external regulatory agencies (see Chapter 3). Results of all assessment activities were considered in the development of the applicable sections of this report.

2.4 ENVIRONMENTAL MANAGEMENT PROGRAMS

BNL has a number of programs designed to protect the environment. Some of the key programs are described below.

2.4.1 GROUNDWATER PROTECTION PROGRAM

BNL has developed a groundwater protection program that focuses on preventing impacts to groundwater and restoring ground-

water quality. Whereas groundwater protection programs at most sites rely solely on groundwater monitoring, at BNL monitoring is used mainly as a tool to determine whether operational or engineered controls are effectively protecting groundwater. In 1997, most of the existing 700 wells onsite were associated with environmental restoration. In conjunction with the Facility Review Project, BNL conducted a thorough review of all active and operational areas onsite that could potentially impact groundwater, and added 84 new wells to monitor those areas. BNL has also developed a groundwater contingency plan that defines an orderly process for taking corrective actions quickly in response to unexpected monitoring results. A key element of that plan and the groundwater program is full and timely disclosure to interested parties. Chapter 7 provides additional details about the Groundwater Protection Program and monitoring results.

2.4.2 WASTE MANAGEMENT FACILITIES AND PROGRAM

The goal of BNL's waste management program is safe and efficient management of waste from generation to ultimate disposal. The program emphasizes pollution prevention/waste minimization (see section 2.4.3). It ensures that there is a defined pathway and budget for disposing of any waste generated, and also that facilities comply with applicable regulatory and permit requirements.

BNL has a Waste Management Facility and Waste Concentration Facility. The Waste Management Facility is a permitted waste storage facility (New York State Department of Environmental Conservation [NYSDEC] Permit No. 1-422-00032/00102-0) consisting of four operations buildings: 855, 860, 865, and 870. See Figure 2-5 for photographs and a description of how each of these buildings is used.

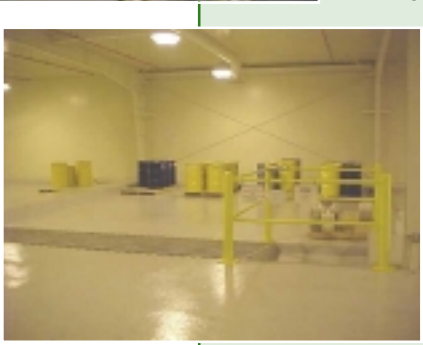
A waste compactor in Building 865 became available for use in 1999. The waste compactor can be used to

Bldg. 860
Offices for technical and professional staff. Staff provide support to facilitate pick-up, storage, and offsite disposal of hazardous, radioactive, and mixed waste.

HAZARDOUS WASTE MANAGEMENT

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

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



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

RADIOACTIVE WASTE MANAGEMENT

Bldg. 865 is used for the sorting, repackaging, and temporary storage of solid low level radioactive wastes generated by site research and maintenance activities. Typical radioactive wastes consist of paper, plastic, glass, and metal.

Most radioactive wastes are received at the Waste Management Facility in plastic bags. After receipt, most of these bags are consolidated into metal bins where they may be further consolidated through compaction. Metals, glass, and heavy objects that could puncture a bag are sometimes packaged directly into these bins or other appropriate containers.

Bldg. 865 contains a compactor for the consolidation of dry, compactible wastes. Bins containing bags of radioactive waste or other compactible materials can be placed directly into this compactor to reduce the volume of the waste by a factor of almost 20. This helps to reduce disposal costs and conserves limited space at the offsite disposal facility.

Prior to shipment offsite, bins containing the waste are stored in below-grade concrete vaults. The bins are inserted into and removed from these vaults by an overhead crane. Only solid radioactive wastes are stored in this building.

MIXED WASTE MANAGEMENT

Bldg. 870 is used for the storage of mixed wastes. These are wastes that are both hazardous and radioactive. This building was designed similar to the Hazardous Waste Storage building, Bldg. 855. Most mixed wastes are generated by research activities and are typically in quantities of 5 gallons or less.

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

Figure 2-5. BNL Waste Management Facilities.

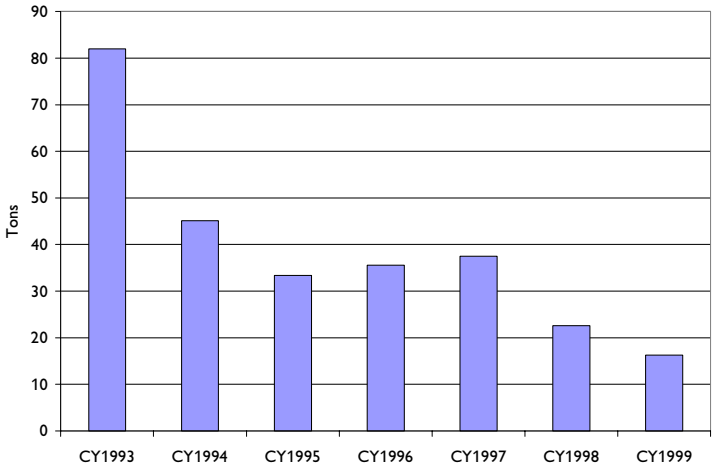


Figure 2-6. Routine Hazardous Waste Generation Trend from 1993-1999.

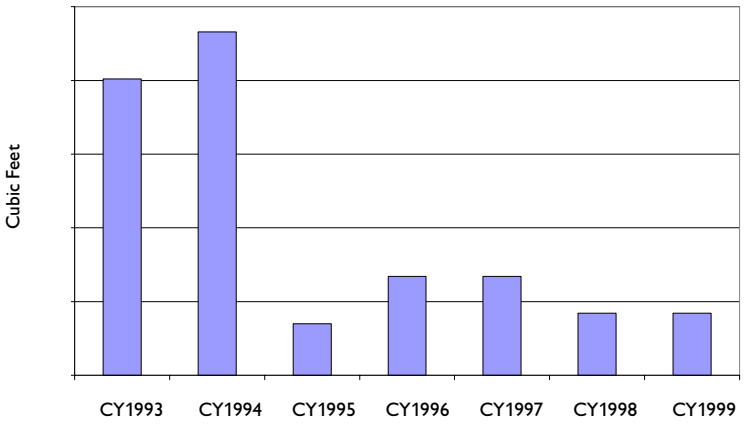


Figure 2-7. Routine Mixed Waste Generation Trend from 1993-1999.

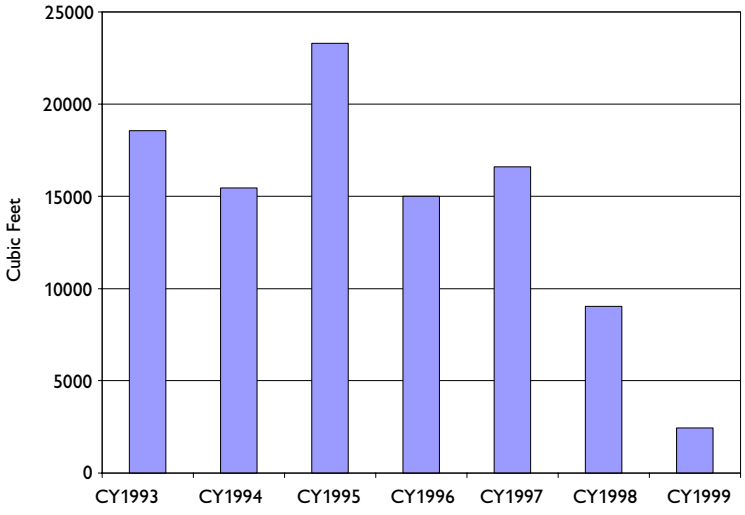


Figure 2-8. Routine Radioactive Waste Generation Trend from 1993-1999.

consolidate and reduce the volume of radioactive wastes such as paper, plastic, glass, and some metals. Compaction will increase packaging efficiency to minimize waste disposal costs and conserve limited space at the disposal facility.

BNL plans to complete an upgrade to Building 865 in 2000 with the construction of a hot cell. The hot cell will allow management of high-activity radioactive wastes in a more cost effective manner.

The Waste Concentration Facility (Building 811) and the Tritiated Water Evaporator (Building 802) are used to manage liquid wastes. Bulk quantities of radioactively contaminated aqueous liquids are stored in Building 811. These liquids are stored in permitted tanks for either onsite processing or offsite treatment and disposal. Building 802 processing consists of evaporating tritiated liquids, which have been treated for the removal of heavy radioisotopes, under the controls imposed by an existing air permit.

There were two upgrades to liquid waste management facilities in 1999. Building 810, an annex to the Waste Concentration Facility, was constructed to improve radioactive liquid transfers. The transfers will be performed in a controlled environment with secondary containment. This annex can also accommodate a second processing unit to concentrate and remove radioactive particles from liquids, which will minimize the amount of waste for treatment or disposal. The Tritiated Water Evaporator was upgraded by replacing the existing evaporating unit with a more energy efficient unit.

In addition to the Waste Management and Waste Concentration Facilities, BNL has twenty 90-Day Hazardous Waste Accumulation Areas. There are also approximately 240 Hazardous Waste Satellite Accumulation Areas, where small quantities of hazardous waste are stored at or near the point of generation. The BNL waste management program manages hazardous and radioactive wastes generated by the Laboratory.

In 1999 BNL generated the following quantities and types of waste from routine operations. (Construction/demolition wastes, environmental restoration wastes, legacy waste, PCB waste, and other wastes determined to be non-routine are not included in these totals or in Figures 2-6 through 2-8.)

- Hazardous Waste: 14.4 tons
- Mixed Waste: 0.8 tons

- Radioactive Waste: 2,427 cubic feet
- Regulated and Toxic Substances Control Act Waste: 1.9 tons

These quantities represent significant reductions.

2.4.3 POLLUTION PREVENTION/WASTE MINIMIZATION

A strong Pollution Prevention/Waste Minimization (P2) Program is another essential element of the EMS. The BNL 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 the BNL operating philosophy.

Key elements of the P2 program are the following:

- Eliminating or reducing wastes, effluents, and emissions at the source where possible; and ensuring that environmental effluents, emissions and wastes are As Low As Reasonably Achievable.
- Procuring environmentally preferable products (also known as "affirmative procurement").
- Conserving natural resources and energy.
- Reusing and recycling materials.
- Achieving or exceeding BNL/DOE waste minimization, pollution prevention, recycling, and affirmative procurement goals.
- Complying with applicable requirements (e.g., New York State Hazardous Waste Reduction Goal, Executive Orders).
- Reducing waste management costs.
- Identifying funding mechanisms for evaluation and implementation of P2 opportunities.
- Implementing P2 projects.
- Improving employee and community outreach and awareness of pollution prevention goals, plans, and progress.

The EMS provides a mechanism for systematically evaluating and implementing value-added pollution prevention opportunities at the Laboratory.

The sustained efforts of the BNL pollution prevention and recycling programs have achieved significant reductions in waste generated by routine operations. From 1993-1999, BNL reduced hazardous waste generation by 80 percent, mixed waste by 79 percent and radioactive waste by 87 percent. Figures 2-6, 2-7, and 2-8 show the trends for these key waste streams.

Implementation of P2 opportunities, recycling programs and conservation initiatives have significantly reduced both waste volumes and management costs. In 1999 alone, these efforts have resulted in over $1,600,000 in cost savings and over 16,000,000 pounds of materials being reduced, recycled, or reused. The 16,000,000 pounds includes 12,850,000 pounds of water conserved through replacement of chillers. Table 2-2 describes the projects that were implemented in 1999, and includes the number of pounds of materials reduced, reused, or recycled and the estimated cost benefit of each project.

BNL also has an active and successful solid waste recycling program. The recycling program involves all employees. Office staff collect paper in designated containers in their work space. Custodial staff collect and consolidate recycled paper to central locations, where it is shipped to the recycling facility. In 1999, BNL collected over 370 tons of paper for recycling. In addition to paper, the recycling program collects many other kinds of materials, including cardboard, bottles and cans, tires, construction debris, motor oil, scrap metals, lead, automotive batteries, printer and toner cartridges, fluorescent light bulbs, machine coolant, and antifreeze. Table 2-3 shows the total number of tons (or units) of these materials recycled in 1999 and the trends since 1992.

2.4.4 WATER CONSERVATION PROGRAM

BNL has a strong water conservation program and has achieved dramatic reductions in water usage. Figure 2-9 shows the five-year trend of water consumption. A comparison of 1999 and 1998 flow figures shows a 180,000,000 gallon reduction in water use for 1999 alone. The reduction of process cooling at the AGS provided the most significant savings. The conversion of the AGS cooling water system to the domestic water supply was completed in 1999. The final component of this project was the addition of a thermostatically controlled throttling valve. By measuring the outlet temperature of the cooling water, the valve is either opened or closed to maximize the temperature rise and to minimize water flow. The full effect of the Phase I Non-Contact Cooling Water Reduction project that was completed in 1998 was also realized in 1999.

The Laboratory is proceeding with Phase II of a Non-Contact Cooling Water Reduction project. The goals of this project are to reduce the consumption of potable water, and reduce

Table 2-2. 1999 Pollution Prevention, Waste Reduction, and Recycling Projects Summary.

Project Description	Reduced,Reused, Recycled or Conserved	Pounds Reduced, Reused, Recycled or Conserved in 1999	Waste Type	Potential Costs for Treatment and Disposal	Cost of Prevention, Reduction, or Recycle	Estimated Cost Benefit	Project Description Details
Paint -1,800 gallons of excess material	Reused	18,000	Hazardous Waste	$12,000	$0	$18,000	1,800 gallons of paint were donated to the Town of Brookhaven for reuse. Material consisted of colors no longer used and small batches of specialty paints. Disposal cost would have been an estimated $12,000. Internal handling, characterization, and transportation costs to disposition as waste would have been an estimated $6,000.
3 Chillers for Cooling Water Systems	Conserved	12,850,000	Wastewater	$2,040	$0	$2,040	During clean out of the Oceanography building, three chillers were identified as available and were reused by Central Shops to replace once-through cooling water systems. Estimated water conservation is 1.5 million gallons, assuming flow rates of 5 GPM and operation for 10 weeks/year for the three systems (12.85 million lbs. of water). Estimated cost for supplying and then disposing of water is $1.35/1,000 gallons.
Millipore RO System	Reused	200	Sanitary	$200	$0	$2,000	During clean out of the Oceanography building, a reverse osmosis system was scheduled for removal and disposal as trash. The system was described in an email to ES&H Coordinators, resulting in a use being identified for biology experiments at the National Synchrotron Light Source. A new system would have cost approximately $1,800.
Lead Bricks for Hot Cell	Reused	172,000	Mixed Waste	$405,725	$100,000	$305,725	Reused over 7,000 radioactive lead bricks for shielding in the hot cell under construction for waste management. Avoided cost of disposal as mixed waste is estimated at $405,725 ($2/lbs. for disposal x 172,000 lbs., plus $61,725 for packaging, handling, and transportation). Project eliminated potential environmental impact of storing radioactive waste bricks.
Waste Oil	Source Reduction	3,500	Hazardous Waste	$6,000	$0	$20,000	350 gallons of waste oil contaminated with chlorinated compounds required disposal as hazardous waste at a cost of $6,000 plus handling. Source of chlorinated compound contamination was identified and replaced with non-chlorinated substitute. Waste oil is now removed free of charge and used for energy recovery. Estimate three batches per year.

continued on next page

Table 2-2. 1999 Pollution Prevention, Waste Reduction, and Recycling Projects Summary *(continued)*.

Project Description	Reduced,Reused, Recycled or Conserved	Pounds Reduced, Reused, Recycled or Conserved in 1999	Waste Type	Potential Costs for Treatment and Disposal	Cost of Prevention, Reduction, or Recycle	Estimated Cost Benefit	Project Description Details
Deionization System Regeneration Wastes	Source Reduction	1,000	Hazardous Waste	$1,000	$9,000	$3,000	Installed a deionization system on the make-up water supply at NSLS cooling water system, allowing longer periods between regeneration of resins. Reduces approximately 110 gallons of hazardous waste, and reduces labor costs by decreasing frequency of regeneration (estimated $2,000 cost avoidance).
Purge Water Low-Flow, Low-Purge Well Sampling	Source Reduction	1,164,000	Radioactive and Hazardous Wastes	$450,000	$23,000	$820,000	Project involved procurement of low-flow, low-purge well sampling equipment and training of sampling team. Eliminates approximately 137,000 gallons (or 1,164,000 lbs.) of contaminated purge water at an estimated cost of $450,000 for treatment and disposal, and reduces labor costs by an estimated $370,000.
Fluorescent Lamps	Recycling	82,248	Hazardous Waste	$109,000	$25,000	$84,000	A total of 41,124 fluorescent bulbs were sent to Mercury Technologies Inc, for recycling in 1999. Estimating 2 lbs./bulb, or a total of 82,248 lbs. of bulbs, disposal of crushed bulbs as mercury waste would have cost approximately $300/drum plus $300/drum labor (crushing, packaging, characterization). At 500 lbs./ drum of crushed bulbs, 165 drums of bulbs would have required disposal ($99,000 for crushing/disposal). Transportation is estimated at $10,000, for a total avoided cost of $109,000.
Fluorescent Lamps	Source Reduction	69,500	Hazardous Waste	$91,740	$40,000	$51,740	29,775 low mercury bulbs were purchased to replace mercury-containing bulbs. Low mercury bulbs can be disposed of at the local landfill as sanitary waste, thus avoiding generation of hazardous waste. At 2 lbs./bulb, 69,500 lbs. of hazardous waste were avoided. Fluorescent bulbs that are hazardous waste cost approximately $1.32/lbs to dispose of, for a total avoided cost of $91,740.
PCB Ballasts	Source Reduction	265	PCB Waste	$1,300	$13,000	$56,000	Proactively removed PCB ballasts in lighting systems. Replacement as a project avoids replacement on a one-by-one basis when a leak occurs. Project cost to replace 53 units estimated at $13,000. Response to a leaker (spill response, sampling, cleanup) estimated at $1,300 or $68,900 for 53 units.

continued on next page

Table 2-2. 1999 Pollution Prevention, Waste Reduction, and Recycling Projects Summary *(concluded)*.

Project Description	Reduced,Reused, Recycled or Conserved	Pounds Reduced, Reused, Recycled or Conserved in 1999	Waste Type	Potential Costs for Treatment and Disposal	Cost of Prevention, Reduction, or Recycle	Estimated Cost Benefit	Project Description Details
Blasocut Machining Coolant	Recycled/Reused	30,385	Industrial Waste	$24,180	$0	$24,180	Central Shops Division operates a recycling system that reclaims Blasocut machining coolant and supplies it labwide. 3,570 gallons (or 65 drums) of Blasocut lubricant were recycled in 1999. Recycling involves aeration, centrifuge, and filtration. Avoids cost of disposal as industrial waste ($300/drum = $19,500), plus handling, characterization, shipping and an avoided cost of procurement of 3 drums of concentrate for a total savings of $24,180. Cost of recycling is estimated to be the same as cost of procurement and preparation of proper dilution for use.
AGS Ion Exchange regeneration wastewater	Source Reduction	127,500	Radioactive	$160,000	$192,000	$136,000	This was a multi-year implementation completed in 1999. Retrofitted ion exchange systems so resins could be removed and disposed as low lead waste, instead of regenerating them. Regeneration produced ~15,000 gallons of radioactive wastewater annually at an estimated cost of $160,000/yr. Resin removal will produce ~130 cubic feet of resin for disposal instead at an estimated cost of $24,000/yr, for a yearly savings of $136,000/yr. (127,500 lbs. ≅15,000 gal).
Cylinders returned to Suppliers from Chemistry Dept	Recycle	565	Hazardous Waste	$25,425	$3,390	$22,035	Returned 113 cylinders from Chemistry Dept tosupplier at a cost of $30/cyclinder, avoiding cost of disposal at an estimated cost of $225/cylinder.
Lead Acid Batteries	Recycled	2,200	Hazardous Waste	$5,000	$0	$5,000	Estimate 50 lbs./battery and five per drum for disposal as hazardous waste at $450/drum plus handling and shipping.
Office Paper	Recycled	740,000	Sanitary Waste	$29,600	$0	$29,600	Estimate $80/ton for disposal as trash.
Cardboard	Recycled	248,000	Sanitary Waste	$9,920	$0	$9,920	Estimate $80/ton for disposal as trash.
Scrap Metal	Recycled	126,000	Sanitary Waste	$5,000	$0	$5,000	Estimate $80/ton for disposal as trash.
Bottles/Cans	Recycled	42,200	Sanitary Waste	$1,690	$0	$1,690	Estimate $80/ton for disposal as trash.
Tires	Recycled	30,400	Sanitary Waste	$1,216	$0	$1,216	Estimate $80/ton for disposal as trash.
Construction Debris	Recycled	704,000	Sanitary Waste	$19,500	$0	$19,500	Estimate $80/ton for disposal as trash.
Antifreeze	Recycled	1,232	Industrial Waste	$1,500	$0	$1,500	Estimate 3 drums for disposal as industrial waste liquid.
Used Motor Oil	Recycled	30,345	Industrial Waste	$30,000	$0	$30,000	Estimate of 70 drums (3,570 gallons) at $450/drum plus characterization, handling packaging and shipping
Lead	Recycled	1,400	Hazardous Waste	$2,000	$0	$2,000	Estimate 3 drums for disposal as hazardous waste.
TOTALS		**16,444,940**		**$1,394,036**	**$405,390**	**$1,650,146**	

Table 2-3. 1999 Recycling Program Summary.

Recycled Material	1992	1993	1994	1995	1996	1997	1998	1999
Mixed Paper	155	136	197	220	106	196	204	370
Cardboard	21	81	164	85	101	103	97	124
Bottles/Cans	12.4	12.4	17.6	11	14.9	21.4	21.8	21.1
Tires	9	21	7	11	17	18.6	11.5	15.2
Construction Debris	809	495	495	627	837	799	527	352
Used Motor Oil (gallons)	—	—	4,000	3,350	4,275	4,600	3,810	3,570
Metals	201	210	33	153	158	266	64	47
Lead	—	—	—	—	—	4.4	3.7	0.7
Automotive Batteries	—	5	0.81	0.72	6.8	4.3	2.1	1.1
Printer/Toner Cartridges (units)	—	—	—	—	—	—	1,480/175	1,575/510
Fluorescent bulbs (units)	—	—	—	—	13,664	12,846	867	41,124
Blasocut Coolant (gallons)	—	—	—	—	—	—	—	3,575
Antifreeze (gallons)	—	—	—	—	55	276	448	145

Notes:
All Units are tons unless otherwise noted.
— denotes either not recycled in that year or data not available.

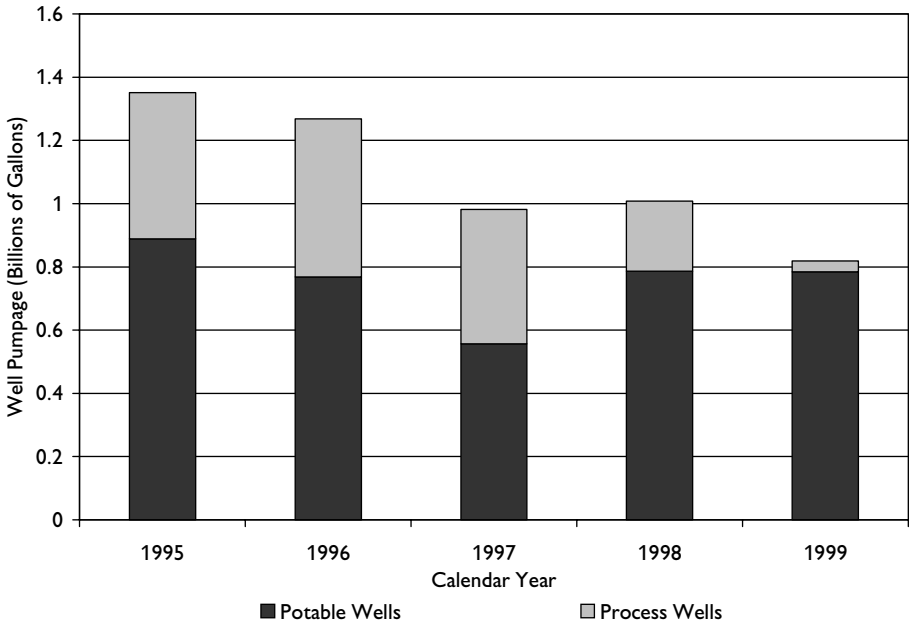


Figure 2-9. Water Consumption Trend 1995-1999.

the impacts of clean water discharges on the operations of the Sewage Treatment Plant. These goals will be achieved by either the replacement of the water cooling system with a closed-loop cooling medium (e.g., chilled water), or by rerouting clean water discharges to recharge basins that then replenish the groundwater supply. In 1999, plans and specifications were drafted to reduce once through cooling water use in Buildings 463 and 535. These plans will be finalized in 2000. Implementation of these improvements will be initiated in the fall so that cooling of facilities is not impacted during construction.

A secondary benefit of the AGS water conversion program was the reduction in equipment maintenance and the improved quality of the water discharge. Under the former cooling system, main magnet heat exchangers at the AGS were back-flushed several times weekly to remove iron deposits. Using the potable water, these exchangers are now backflushed no more than twice each year. Performance of the recharge basin that receives

this discharge has improved as a result. The basin was previously scraped every 12-18 months to remove iron scale that clogs soil pores and prevents leaching. The basin has not been scraped in two years and leaching efficiency is still high.

2.4.5 ENERGY MANAGEMENT AND CONSERVATION

Many of the BNL scientific experiments use particle beams generated and accelerated by electricity with the particles controlled and aligned by large electromagnets. The Laboratory spends over $22 million for energy each year. To help deal with large energy expenditures, as well as meet DOE goals for energy conservation, BNL's Energy Management Group was established in 1979. It is responsible for the development, implementation and coordination of BNL's energy management plan.

Energy initiatives that took place in 1999 included the following:

- Completion of a new efficient steam absorption chiller at BNL's Central Chilled Water Facility, which is estimated to save over 60,000 mmbtu/year in energy and over $150,000/year in energy costs. (Note: This cost avoidance is not reflected in Table 2-2.)
- Initiation of a Controls System Optimization Project for five buildings. This project will recommission the existing energy management control system, reestablish proper scheduling and control points, and add new energy saving features. Based on recent experience, a 10 percent reduction in energy use is expected.
- Substantial completion of a steam station/manhole insulation project. In steam stations, the piping, valves and other components where original insulation had been damaged or removed will be reinsulated. New removable insulation jackets will be installed in manhole valves and expansion joints. This project will reduce energy loss and improve conditions in the spaces by reducing the temperature, thus providing a safer working environment.
- Substantial completion of a lighting project to replace incandescent exit signs that contain tritium with light emitting diode (LED) signs. The tritium signs were taken out of service and returned to the manufacturer, eliminating the risk of radioactive release. The manufacturer exchanged the tritium signs with highly efficient and environmentally benign LED signs, at a cost savings.
- Initiation of a Side-Stream Filtration Project at the Central Chilled Water Facility. Under this project, a filter system will be installed to remove fine particulates in water. If not removed, small particles can attach to various water system components and result in corrosion and buildup of scale. This in turn reduces the heat transfer capability of the heat exchange surfaces, which increases energy use. It also degrades the system, causing premature failures.

Together, these projects are estimated to save over $1 million/year in energy costs each year and help further progress towards the DOE energy goals.

DOE Order 430.2 (1996), *In-House Energy Management*, set a goal to demonstrate, on an annual basis, continual cost-effective improvement in reducing building energy use per square foot and increasing energy efficiency in industrial facilities. Success is measured by comparing current year consumption to the prior year. Energy management initiatives have been very successful at BNL. Laboratory energy-use per square foot of building for 1999 was 28 percent less than in 1985, well ahead of the DOE goal of a 20 percent reduction by 2000 (see Figure 2-10).

2.4.6 EMPLOYEE TRIP REDUCTION PLAN (RIDESHARE)

BNL has had a rideshare program since 1995. This program was developed to comply with the Employee Travel Reduction Program rule (17 NYCRR 38). The New York State Department of Transportation repealed the rule in September 1996, in effect making employer participation in the program voluntary. Although the program is voluntary, BNL continues to assist employees in finding suitable rideshare partners by maintaining a ride-matching database. The Laboratory still provides a guaranteed ride service for program participants, and continues to subsidize the cost of a defensive-driver course for employees active in ridesharing partnerships.

2.5 ENVIRONMENTAL MONITORING

The Laboratory has established a comprehensive, multi-media environmental monitoring program to determine whether current BNL operations affect the environment and to ensure compliance with environmental permit require-

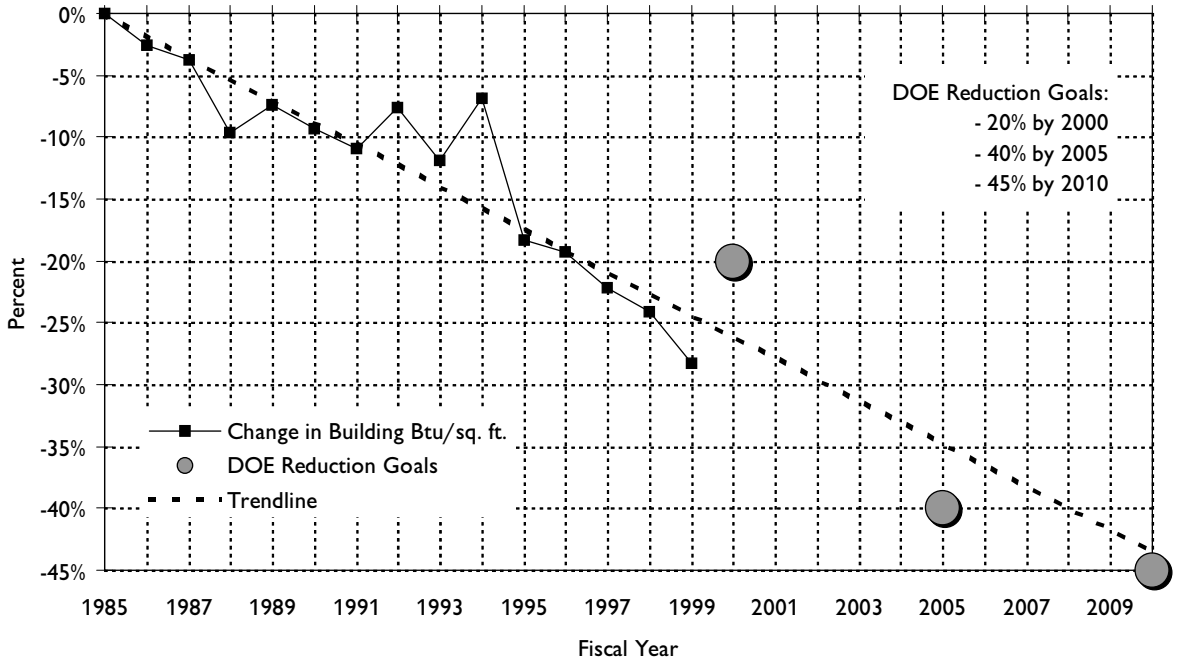


Figure 2-10. Building Energy Performance Since 1985.

ments. The monitoring program is reviewed, and revised as necessary, on an annual basis to reflect changes in permit requirements, changes in facility-specific monitoring activities, and the need to increase or decrease monitoring based upon the review of previous analytical results. As required under DOE Order 5400.1 (1988), an Environmental Monitoring Plan outlines annual sampling goals by specific media and frequency. Over 4,729 samples were collected in 1999 as part of the Environmental Monitoring Program, as shown in Table 2-4.

The monitoring program identifies potential pathways for exposure of the public and the environment, as well as evaluating what impact BNL activities may be having on the environment. There are three components to the environmental monitoring program:

- *Compliance monitoring* is conducted to ensure that wastewater effluent, air emissions and groundwater monitoring data comply with regulatory and permit limits (issued under the federal Clean Air Act, Clean Water Act, Oil Pollution Act, Safe Drinking Water Act and New York State equivalents).
- *Restoration monitoring* is performed to determine overall impacts of past operations, to delineate the real extent of contamination, and to ensure that remedial systems are performing as designed (under CERCLA and Resource Conservation and Recovery Act).
- *Surveillance monitoring* is conducted to ensure there are no negative impacts on the environment from Laboratory operations (under DOE Order 5400.1).

These programs can be broken down further by the relevant law or requirement (e.g., State Pollutant Discharge Elimination System [SPDES] or Clean Air Act) and even further by specific environmental media and type of analysis. Control or background (reference) samples are also collected in order to compare BNL results to areas that could not have been impacted by BNL operations.

2.5.1 COMPLIANCE MONITORING

Compliance monitoring is performed in accordance with environmental requirements (permits, regulations, etc.). These requirements may be separated into three categories: air, wastewater and groundwater.

- Air emissions monitoring is conducted at reactors, accelerators and other radiological emission sources as well as the Central Steam Facility. Real-time, continuous emission monitoring or continuous sample collection equipment

Table 2-4. BNL 1999 Sampling Program - Summary of Samples Collected Sorted by Media.

Media	No. of Samples Collected in 1999	Purpose
Groundwater	2,122	Monitoring is performed under the Environmental Restoration and Environmental Surveillance programs to evaluate any impacts of past and present operations on groundwater quality.
Air - Tritium	613	Silica gel cartridges are used to collect atmospheric moisture for subsequent tritium analysis. These data are used to assess tritium levels downwind of the reactors. Due to several years of no detection, monitoring was reduced from weekly to monthly in several areas of the site in 1999.
Air - Particulate	486	Gamma analysis is performed on samples of particulate matter collected from air samples. The purpose is to verify that there has been no impact from BNL operations.
Air - Charcoal	191	Charcoal samples are used to assess for radioiodines, which could be released in reactor emissions.
Potable Water	214	Potable water wells and the BNL distribution system are monitored routinely for chemical and radiological parameters to ensure compliance with SDWA requirements and for environmental surveillance purposes.
Fauna	27	Fish and deer are routinely monitored to assess impacts on wildlife associated with past BNL operations.
Flora	4	Since the primary pathway from soils to fauna is via ingestion, vegetation is sampled to assess uptake of contaminants by plants, and hence to fauna. Monitoring in 1999 consisted of collection of saltwater flora.
Onsite Recharge Basins	128	Recharge basins used for wastewater and stormwater disposal are monitored in accordance with SPDES requirements and for environmental surveillance purposes.
Sewage Treatment Plant	691	The STP influent and effluent and several Peconic River stations downstream are monitored routinely for organic, inorganic, and radiological parameters to assess BNL impacts on the estuary.
Precipitation	10	Precipitation samples are routinely collected from two locations to determine impacts of Laboratory emissions on rainfall.
Soils	243	Soil samples are collected from adjacent farms and other local areas to confirm that Laboratory emissions have no impact on surrounding areas. Soil samples are also collected in conjunction with Environmental Restoration investigative work.
Total Samples Collected in 1999	**4,729**	

is installed and maintained at these facilities, as required by permit conditions. Analytical data are reported routinely to the permitting authority (see Chapter 3 for details).

- Wastewater discharges are subject to Clean Water Act permit monitoring requirements. Monitoring is performed at the point of discharge, and is used to ensure that the effluent complies with release limits. Thirteen point source discharges are monitored under the BNL program: three from the Environmental Restoration (ER) program, and ten under the SPDES program. Samples are collected daily, weekly, monthly, or quarterly as required by permit conditions, and monitored for organics, inorganics and radiological parameters. Monthly reports are filed with the permitting agency, which provide analytical results and an assessment of compliance for that reporting period.
- Groundwater monitoring is also performed in accordance with permit requirements. Specifically, monitoring of groundwater is required under the Major Petroleum Facility License for the Central Steam Facility, and the Resource Conservation and Recovery Act permit for the Waste Management Facility. Extensive groundwater monitoring is also conducted under the ER program as required under the Records of Decision for many of the Operable Units or Areas of Concern (see Chapter 7 for details). Additionally, to ensure that the Laboratory maintains a viable potable water supply, groundwater is monitored as required by the New York State Department of Health (see Chapter 3 for details).

2.5.2 ENVIRONMENTAL SURVEILLANCE MONITORING

The focus of the environmental surveillance program is to assess potential environmental impacts resulting from routine facility operations. This program includes collection of ambient air, surface water, groundwater, flora, fauna, and precipitation samples. Samples are analyzed for radiological, organic, and inorganic contaminants. Additionally this program performs routine review of data collected by thermoluminescent dosimeters (devices to measure radioactive exposure) placed onsite and offsite.

2.5.3 ENVIRONMENTAL RESTORATION MONITORING

Monitoring performed under the ER program is conducted to determine if past operations released or deposited contaminants in the environment or otherwise resulted in degradation of environmental media. This program typically includes collection of soil and groundwater samples in order to determine the lateral and vertical extent of the contaminated area. These samples are analyzed for organics, inorganics and radiological contaminants and the analytical results compared with recognized guidance or background concentrations. Areas where impacts have been confirmed are fully characterized and if necessary, remediated to mitigate continual impacts. Follow-up monitoring of groundwater is conducted in accordance with a Record of Decision.

The results of monitoring and the analysis of the monitoring data are the subject of the remainder of this Site Environmental Report. Chapter 3 summarizes environmental requirements and compliance data; Chapters 4 through 8 give details on media-specific monitoring data and analysis; and Chapter 9 provides supporting information for understanding and validating most of the data shown in this report.

2.6 ENVIRONMENTAL RESTORATION (ER) PROGRAM

In 1980 the U.S. Congress enacted the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, also known as Superfund) to ensure that sites with historical contamination were cleaned up, and to hold the responsible party liable for the cleanup. CERCLA established the National Priorities List (also known as the NPL). The NPL is a list of sites nationwide where cleanup of past contamination is required. In November 1989, BNL was included as one of more than 30 sites on the NPL that are located on Long Island. Much of the contamination at BNL is due to past accidental spills and practices for handling chemical and radiological material storage and disposal.

BNL follows the process mandated by CERCLA, which includes

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

At each step, EPA distinguishes between sites that do or do not require further action, based on threat to human health and the environment. An expedited cleanup action, called a *Removal Action*, can also be conducted. This only requires an *Engineering Evaluation/ Cost Analysis*. This document evaluates and recommends specific cleanup actions. See Figure 2-11 for a flow chart that illustrates the CERCLA process.

The Laboratory's ER program has been characterizing and removing sources of contamination (e.g., underground tanks and pools) or treating the groundwater and soil contamination resulting from past BNL practices. ER groundwater cleanup efforts have included monitoring of existing groundwater wells, overseeing the installation of new, permanent groundwater monitoring wells, installing groundwater treatment systems and extension of public water service. During 1999, 757,000,000 gallons of groundwater were treated, and at least 634 pounds of volatile organics were removed. Since the first system started operating in December of 1996, a total of 1,566 pounds of volatile organic compounds have been removed from almost two billion gallons of groundwater. (See Chapter 7 for more information.) BNL has identified contami-

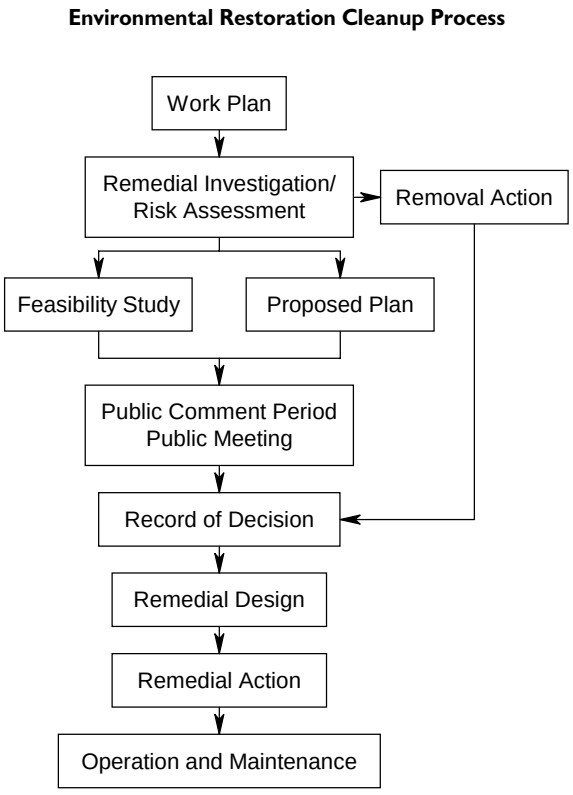


Figure 2-11. Flowchart of the CERCLA Process.

nated soils through extensive surveys and sampling. These studies have resulted in various projects involving soil removal and treatment. Several landfills have been capped and fifty-five waste pits have been excavated. Some of the excavated waste has been sent to an offsite licensed facility; the other wastes are being stored onsite and managed, awaiting final disposition.

2.6.1 ENVIRONMENTAL RESTORATION PROGRAM PROGRESS BY OPERABLE UNIT (OU)

Historical facility records and sampling have been used to determine where contamination might be present on the site today. These areas were geographically grouped into Operable Units (OU) (see *Areas of Concern at BNL, Upton, New York - A Reference Handbook*. [BNL 1988a]). Table 2-5 provides a description of each OU (I - VII) and the ER actions taken during 1999. Photographs in Figures 2-12 through 2-15 show ER activities conducted during 1999. See Chapter 7 for a more detailed discussion of groundwater monitoring and restoration programs.

2.6.1.1 OPERABLE UNIT V – THE PECONIC RIVER

Significant progress was made in OU V during 1999. Samples for plutonium and related radionuclides were collected from

- sludge in out-of-service sewer line (now capped) that once led to the the Sewage Treatment Plant;
- soils at the Sewage Treatment Plant;
- groundwater in the vicinity of and downgradient of the Sewage Treatment Plant and at background reference locations (18-30 miles west of BNL);
- surface water and sediment in the Peconic River (which receives BNL's treated sewage effluent) and in the Connetquot River (which was used as a reference location); and
- fish from the Peconic River.

BNL analytical results agreed closely with results from split samples analyzed by the EPA, the NYSDEC, the Suffolk County Department of Health Services and the DOE's Environmental Measurements Laboratory. Plutonium was detected in all media at levels below those requiring health-based cleanup levels. The results were shared with the regulatory agencies, the community, civic organizations and advisory councils (BNL 2000).

Some community members and stakeholders have advocated phytoremediation, which uses plants to extract contaminants from sediment. In the spring of 1999, an evaluation of phytoremediation in the Peconic River was completed by the two industry leaders in this technology. According to studies, although phytoremediation is a promising innovative technology, application of it to sediments in the Peconic River and associated wetlands has several limitations. Phytoremediation may not be effective at meeting the cleanup goals for all contaminants to be removed from the Peconic River, since much of the area proposed for cleanup is heavily vegetated and would require excavation to clear the area for phytoremediation studies. Also, prolonged time periods may be necessary to reach cleanup goals, if they were achievable, for some contaminants such as copper.

In September, the Final Feasibility Study of engineering alternatives for OU V cleanup was placed in the Administrative Record for public review. A final report of the plutonium sampling results was placed in the Administrative Record on 2/4/00. See Chapter 7, pages 26-31

Table 2-5. Environmental Restoration Program Progress by Operable Unit.

Operable Unit or Project	Description and *Contamination Type*	1999 CERCLA Actions
Operable Unit I	Former Hazardous Waste Management Area, Landfills, and Disposal Pits *Radiological soil contamination, primarily cesium-137*	• Regulatory approval of the Operable Unit I Record of Decision (ROD) • Completed addendum to the Sampling Plan for the OU I wooded wetlands and collected and analyzed samples • Completed Treatablitiy Studies Report and sludge removal from the Bldg. 811 underground storage tank waste • Processed 1,000 cubic yards of debris from the Chemical Holes for disposal • Treated 5,000 gallons of decontamination fluids for low level strontium-90 • Treated and disposed 150 lbs. of liquid mercury • Continued operation of the OU I South Boundary Pump and Treat System (formerly RA V)
Operable Unit II/VII	AGS Scrapyard and Soil Contamination *Radiological soil contamination, primarily cesium-137 and strontium-90*	• Action Memorandum for the Brookhaven LINAC Isotope Producer (BLIP) project revised and submitted to DOE • Regulatory approval of the Operable Unit I Record of Decision (included OU II AOCs)
Operable Unit III	Potable Supply Wells/Spills *Chemical and radiological groundwater contamination, primarily VOCs, tritium and strontium-90*	*Remedial Investigation/Feasibility Study (RI/FS)* • Held public comment period and meetings for RI/FS • Continued review and revision of the OU III ROD *Onsite Actions* • Completed 90% Design of the groundwater treatment system for VOCs in the Former Scrapyard & Drum Storage Area south of Bldg. 96 • Excavated 340 cubic yards of PCB-contaminated soil in the Former Scrapyard & Drum Storage Area • Completed shipment of contaminated soils from Bldg. 830 • Completed the removal of two underground storage tanks and excavation of contaminated soil from Bldg. 830 • Treated over 80,000 gallons of groundwater and removed over 61 pounds of carbon tetrachloride • Continued operation of the OU III South Boundary Groundwater Pump and Treat System • Removed 757 million gallons of water and 634 lbs. of VOCs from all treatment systems from the aquifer during 1999 *Offsite Actions* • Construction of the first offsite groundwater treatment system was completed and system startup began in September 1999 *HFBR Tritium* • Installed 46 geoprobe wells, 11 vertical profiles, and 11 monitoring wells to monitor the HFBR tritium plume • Continued operation of the tritium pump and recharge system
Operable Unit IV	Central Steam Facility Spill and Bldg. 650 Sump Outfall *Chemical and radiological soil and groundwater contamination*	• Continued operations, maintenance, and monitoring at the Air Sparge/Soil Vapor Extraction System (AS/SVE) • Bldg. 650 Groundwater Modeling Report was presented to the Suffolk County Department of Health Services • Continued interim remedial monitoring for the Bldg. 650 Sump and Sump Outfall Area
Operable Unit V	Sewage Treatment Plant and Peconic River *Heavy metal and radiological sediment and soil contamination, primarily mercury, silver, copper, and cesium-137*	• Completed the OU V Feasibility Study Report • In May 1999, completed additional radiological sampling of water and sediments from the Peconic River, groundwater from wells in the vicinity of and downgradient of the Sewage Treatment Plant, and soils from the Sewage Treatment Plant, and sludge in retired and capped sewer pipes • Held four information sessions to inform residents of sampling results

continued on next page

Table 2-5. Environmental Restoration Program Progress by Operable Unit *(continued)*.

Operable Unit or Project	Description and *Contamination Type*	1999 CERCLA Actions
Operable Unit VI	Biology Fields *Pesticide groundwater contamination-ethylenedibromide (EDB)*	• Continued revisions on the OU VI ROD • Developed preliminary action plan to include a contingency remedy in addition to monitoring • Installed two vertical profile wells and two permanent monitoring wells
Groundwater Monitoring	Ongoing Sitewide Project	• Completed the 1998 ER Sitewide Groundwater Monitoring Report • Completed the BNL Groundwater Monitoring Program Quality Assurance Project Plan • Collected and analyzed over 1,300 groundwater samples from 16 monitoring programs
Brookhaven Graphite Research Reactor (BGRR)	*Radiologically contaminated water and fans, primarily cesium-137.*	• Completed the Baseline for the BGRR Decommissioning Project • Completed the BGRR Project Management Plan • Removed temporary walls from the BGRR high bay area to restore the facility for decommissioning planning and characterization of components and areas • Disposed of 35,500 gallons of contaminated water removed from the below ground ducts • Removed the first of five primary air handling fans weighing approximately 23,000 lbs. • Entered into the administrative record, the DOE approved CERCLA Time Critical Removal Action Memorandum for removal of the Pile Fan Sump, piping, and associated soils

of the *Site Environmental Report for Calendar Year 1997* (BNL 1999) for additional information on this sampling project.

2.7 COMMUNICATION AND COMMUNITY INVOLVEMENT

After the High Flux Beam Reactor tritium incident in 1997 (see the *Tritium Remediation Project, High Flux Beam Reactor, Summary Report* [BNL 1998b] for more information), the New York State Attorney General stated that he believed that BNL needed to "step outside the Laboratory's gates and demonstrate a commitment to the entire Long Island community" (Vacco 1998). All programs described in this chapter emphasize timely, ongoing and meaningful communication with stakeholders on findings and progress. The Laboratory continues efforts to improve working relationships with regulatory agencies by sharing information and working to resolve issues on plans, priorities, and corrective actions. BNL has maintained an open door policy with the regulators. For example, Suffolk County and Region II EPA have liaison staff with offices located at the Laboratory. Quarterly meetings are held with EPA on the MOA projects and other operations of interest. Biweekly meetings are held with Suffolk County on the Facility Review Project.

BSA has invested tens of millions of dollars in programs geared towards improving the Laboratory's environmental systems and performance. The MOA demonstrated BNL's willingness to make major changes in its programs, and involve the regulators at every step along the way. DOE and BNL have entered into several other Consent Orders/Agreements (described in Chapter 3) with the regulators to address compliance concerns. BNL project and senior managers have made communicating regularly on progress and honoring commitments a high priority. The Laboratory Director's frequent presence at meetings with the regulators and the community demonstrates his personal commitment to environmental stewardship.

BNL has also established a Community Advisory Council, similar to those at other DOE sites undergoing environmental restoration. The Council consists of representatives from 32 varied stakeholder organizations, including civic, business, union, health, education, and environmental groups. The Council advises the Laboratory Director and sets its own agenda. In addition, DOE established the Brookhaven Executive Roundtable. The Roundtable is made up of representatives from elected officials and regulatory agencies. The Roundtable provides a forum for updating members and the public on

◀ **Figure 2-12. Groundwater Treatment System.** In September 1999, BNL celebrated the start-up of the first offsite groundwater treatment system. This system, located in an industrial park just south of the Laboratory, uses in-well air stripping to remove chemicals from area groundwater.

Figure 2-13. Soil Removal. ▶ In October 1999, a layer of soil approximately six inches deep containing PCBs was removed from the Building 96 area.

Figure 2-14. Soil and Groundwater Sampling. ▶ In April 1999, as part of the Operable Unit V plutonium investigation, soil and groundwater samples were taken at BNL's Sewage Treatment Plant and analyzed for radionuclides.

◀ **Figure 2-15. Sediment Sampling.** In the spring of 1999, sediment samples were taken from locations along a 17-mile stretch of the Peconic River between BNL and the town of Riverhead. These samples were analyzed for plutonium and other radionuclides.

issues that may be of interest to them. The Laboratory offers to make subject matter experts available to give presentations and to respond to questions and concerns in real time to these groups and other outside organizations. BNL also has an Envoy Program, which builds on relationships that BNL employees have established within community organizations, as a way to communicate to a broader audience.

Other public outreach activities include monthly briefings to local civic associations; meetings and presentations to local, state and federal regulators and elected officials; and regular interactions with the business and educational community. In 1999, BNL hosted more than 20,000 student visitors, and another 4,900 people visited the Laboratory through its Summer Sunday programs. To highlight the cutting-edge environmental research conducted at the Laboratory and provide information regarding cleanup initiatives, the Laboratory hosted an Environmental Fair, which drew over 3,000 visitors. The Laboratory also issues press releases, publishes the *Brookhaven Bulletin* (a weekly employee newsletter) and *cleanupdate* (a periodic newsletter on environmental cleanup), and issues e-mail updates to inform the public and staff about environmental activities.

This annual Site Environmental Report summarizes BNL's environmental program and performance for the 1999 calendar year. The Laboratory is exploring other mechanisms to communicate data in a more user friendly, visual and timely manner. A great deal of information about BNL's environmental programs is already on BNL's website. Environmental project plans, status reports, procedures, and more are accessible to the general public on the Internet at <http://www.esh.bnl.gov/esd/>.

2.8 ENVIRONMENTAL STEWARDSHIP AT BNL TODAY

BNL now has an unprecedented knowledge of potential environmental vulnerabilities and current operations. Compliance assurance programs described in Chapter 3 are improving BNL's compliance status. Pollution prevention projects have resulted in millions of dollars of cost savings/costs avoided, and have prevented millions of pounds of waste from being generated or disposed. In 1999 the RHIC facility was officially certified to the ISO 14001 Standard. In 1999 BNL also received an overall "Excellent" performance rating from DOE.

The Laboratory is openly communicating with neighbors, regulators, employees and other interested parties on issues and progress. BNL must continue to deliver on commitments and demonstrate real improvements in their environmental performance in order to regain the stakeholders' trust.

For 50 years, the unique, leading-edge facilities at BNL have made many innovative scientific contributions possible. Today, BNL continues its research mission while paying much closer attention to cleaning up and protecting the environment. The Laboratory's new environmental motto, which was generated in an employee suggestion contest, is "Exploring Earth's Mysteries...Protecting Its Future." This reflects BNL's desire to balance world-class research with environmentally responsible operations.

REFERENCES

17 NYCRR 38. New York State Department of Transportation. "Employee Travel Reduction Program." *New York Codes, Rules and Regulations*. (Repealed September 1996.)

BNL. 1998a. *Areas of Concern at Brookhaven National Laboratory, Upton, New York - A Reference Handbook*. June 1998.

BNL. 1998b. *Tritium Remediation Project, High Flux Beam Reactor, Summary Report*. Brookhaven National Laboratory, Upton, New York. March 1998. 14

BNL. 1999. *Site Environmental Report for Calendar Year 1997*. BNL-52553. Brookhaven National Laboratory, Upton, New York. February 1999.

BNL. 2000. *Operable Unit V Final Plutonium Contamination Characterization and Radiological Dose and Risk Assessment Report*. BNL/OU5/10.7/2634-3623 04-FEB-00. Brookhaven National Laboratory, Upton, New York. February 4, 2000.

DOE Order 430.2. 1996. *In-House Energy Management*. U.S. Department of Energy, Washington, D.C. 6-13-96 (expired 6-13-00).

DOE Order 5400.1. 1988. *General Environmental Protection Program*. U.S. Department of Energy, Washington, D.C. Change 1: 6-29-90.

EPA/DOE. 1998. "Memorandum of Agreement by and between the Environmental Protection Agency and the United States Department of Energy." EPA and DOE. March 23, 1998.

Vacco, D.C., State of New York Office of the Attorney General. Letter to Martha Krebs, DOE Director of the Office of Energy Research. July 1, 1998.