Final Five-Year Review Report

for

Brookhaven National Laboratory Superfund Site
Town of Brookhaven, Hamlet of Upton
Suffolk County, New York

July 2006

PREPARED FOR:
The United States Department of Energy
Office of Environmental Management

PREPARED BY:
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Executive Summary

The U.S. Department of Energy (DOE) owns the Brookhaven National Laboratory (BNL) federal facility site and is the lead agency for the Five-Year Review. DOE entered into a Federal Facilities Agreement (also referred to as the Interagency Agreement, or IAG) for the BNL site, along with the U.S. Environmental Protection Agency (EPA) and the New York State Department of Environmental Conservation (NYSDEC). Brookhaven Science Associates (BSA), under contract with the DOE, manages and operates BNL.

The remedies for the BNL Superfund site in Upton, New York include excavation and off-site disposal of contaminated soil, sediment, tanks, structures, capping of landfills, installation and operation of groundwater treatment systems, groundwater monitoring, and institutional controls. All of the remedies for the seven signed Records of Decision (RODs) have been implemented except for remaining Operable Unit (OU) I soil excavation at the former Hazardous Waste Management Facility Waste Loading Area and disposal and the Brookhaven Graphite Research Reactor (BGRR) pile and bioshield removal, and installation of the cap.

A Five-Year Review that was prepared in September 2003 focused specifically on the BNL OU IV remedy. This 2005 Review is comprehensive and covers all of the OUs for the BNL site.

The activity that triggered this first 2005 sitewide Five-Year Review was the start of construction for the OU I contaminated landscape soils, on July 18, 2000. According to data reviewed from the closeout reports, the annual groundwater status reports, site inspections, and regulatory interviews, the remedies were implemented in accordance with the RODs and the *OU III Explanation of Significant Differences (ESD).* The soil cleanup levels were met and the groundwater pump and treat systems have been functioning as intended by the RODs. The cleanup performed continues to meet the remedial action objectives identified in each ROD.

Long-term protectiveness of the Peconic River remedy will be verified by continuing to monitor the sediment, surface water, fish, and revegetation. In addition to annual reporting of the analytical results, the monitoring data will be evaluated during the second sitewide Five-Year Review in 2011 to evaluate the effectiveness of the remedy in meeting the cleanup and restoration objectives. The potential need for additional actions will also be evaluated.

For the OU I soil excavation remedies, the work was performed in accordance with the ROD, applicable design documents, and Remedial Action Work Plans. The soil cleanup levels were met for these areas. The remaining work for the OU I soil excavation at the former Hazardous Waste Management Facility Waste Loading Area and BGRR will be implemented in accordance with the RODs. The remedies are expected to be protective upon attainment of soil cleanup goals once excavation is complete and the groundwater cleanup goals have been met.

A comprehensive sitewide protectiveness determination covering all the OUs and the BGRR must be reserved at this time because:

- Work is not complete for OU I soils at the Waste Loading Area.
- Work is not complete for the BGRR pile, bioshield, and final engineered cap.
- The final remedy for the g-2 Tritium Plume, Brookhaven Linac Isotope Producer (BLIP), and Underground Storage Tanks (USTs) (Areas of Concern [AOC] 16T, 16K, and 12) has not yet been selected. The ROD is due for submittal to the regulators in the fall of 2006.

The second Sitewide Five-Year Review in 2011 will include all OUs, including the g-2 Tritium Plume, BLIP, and USTs. A comprehensive sitewide protectiveness determination will be included at that time. The table below provides a summary of the issues and recommendations by OU from the 2005 Five-Year Review.

Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Document OU I and OU V monitoring and maintenance requirements in one document	Prepare and submit the OU I Soils and OU V Long-Term Monitoring and Maintenance Plan to the regulators	BNL	DOE, EPA, DEC, SCDHS	July 2005 (actual of 8/12/05)	N	N
Some USTs in AOC 12 are not documented as final remedies in a ROD	Document the final remedy for remaining AOC 12 USTs in the g-2/BLIP ROD	BNL	DOE, EPA, DEC, SCDHS	October 2006	N	N
OU I - Animal burrows in Current Landfill cap, and gates broken	Repair current burrows and fix gates	BNL	DOE, EPA, DEC, SCDHS	July 2005 (gates fixed 12/16/05, burrows repaired 2/27/06)	N	N
OU I - Consistent long-term results from Wooded Wetland Monitoring	Evaluate the need to continue the annual sampling or reduce the frequency	BNL	DOE, EPA, DEC, SCDHS	September 2005 (actual of 8/12/05)	N	N
Institutional controls documentation needs updating	Update Land Use Controls Management Plan and web-based database	BNL	DOE, EPA, DEC, SCDHS	September 2005 (Plan updated 6/17/05)	N	Y
OU I - Consistent low VOCs in OU I extraction wells	Implement pulse pumping of treatment system to optimize performance	BNL	DOE, EPA, DEC, SCDHS	October 2005 (actual of 9/6/05)	N	N
OUs III, VI - Deeds not reflecting operating treatment systems	Complete survey/mapping of treatment systems off of BNL property and record updated deeds with County	BNL	DOE, EPA, DEC, SCDHS	June 2005 (survey/mapping completed 6/30/05)	N	Y
OU III - Consistent low VOCs in WSB extraction wells	Implement pulse pumping of treatment system to optimize performance	BNL	DOE, EPA, DEC, SCDHS	October 2005 (actual of 9/6/05)	N	N
OU III - Consistent low VOCs in IP recirculation well	Implement pulse pumping of UVB-1 to optimize performance	BNL	DOE, EPA, DEC, SCDHS	October 2005 (actual of 10/05)	N	N
OU III - Consistent low VOCs in Airport recirculation wells	Implement pulse pumping of treatment system to optimize performance	BNL	DOE, EPA, DEC, SCDHS	October 2005 (actual of 10/3/05)	N	N
Enhance monitoring well network	Implement changes to various well networks based on 2004 Groundwater Status Report	BNL	DOE, EPA, DEC, SCDHS	October 2005 (actual of 10/05)	N	N
OU V – Restore haul roads	Per the DEC equivalency permit, remove stone/fabric	BNL	DOE, EPA, DEC, SCDHS	September 2005 (actual of 9/30/05)	N	N

Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Housekeeping	Dispose of miscellaneous monitoring well materials at Meadow Marsh & 650 Outfall, remove Spray Aeration piping and RA V tanks	BNL	DOE, EPA, DEC, SCDHS	August 2005 (Spray Aeration piping removed 1/11/06)	N	N

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name *(from WasteLAN)*: Brookhaven National Laboratory Superfund Site		
EPA ID *(from WasteLAN)*: NY7890008975		
Region: 2	**State:** NY	**City/County:** Upton, Suffolk

SITE STATUS	
NPL status: ☒ Final ☐ Deleted ☐ Other (specify)	
Remediation status (choose all that apply): ☒ Under Construction ☒ Operating ☒ Complete	
Multiple OUs?* ☒ YES ☐ NO	**Construction completion date:** ___ / ___ / _____
Are the properties associated with this site in use or are they suitable for reuse? ☒ YES ☐ NO	

REVIEW STATUS	
Lead agency: ☐ EPA ☐ State ☐ Tribe ☒ Other Federal Agency (DOE)	
Author name: Rodrigo V. Rimando, Jr.	
Author title: DOE Federal Project Director and IAG Remedial Project Manager	**Author affiliation:** U.S.DOE, Office of Environmental Management, Upton, NY
Review period:** 7/18/2000 to 7/18/2005	
Date(s) of site inspection: 3/10/05 through 5/24/05	
Type of review: ☒Post-SARA ☐ Pre-SARA ☐ NPL-Removal only ☐Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead ☐Regional Discretion	
Review number: ☒ 1 (first) ☐ 2 (second) ☐ 3 (third) ☐ Other (specify) _____	
Triggering action: ☒ Actual RA Onsite Construction at OU I ☐ Construction Completion ☐ Other (specify)	☐ Actual RA Start at OU#____ ☐ Previous Five-Year Review Report
Triggering action date *(from WasteLAN)*: 7/18/2000	
Due date *(five years after triggering action date)*: 7/18/2005	

* ["OU" refers to operable unit.]
** [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

Five-Year Review Report

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List of Acronyms

ALARA	As Low As Reasonably Achievable
AOC	Area of Concern
AS/SVE	Air Sparging/Soil Vapor Extraction
BER	Brookhaven Executive Round Table
BGD	belowground duct
BGRR	Brookhaven Graphite Research Reactor
BHSO	Brookhaven Site Office
BLIP	Brookhaven Linac Isotope Producer
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates
CAC	Community Advisory Council
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFR	*Code of Federal Regulations*
CSF	Central Steam Facility
DOE	Department of Energy
DQO	Data Quality Objective
EDB	ethylene dibromide
EPA	Environmental Protection Agency
ESD	*Explanation of Significant Differences*
gpm	gallons per minute
HFBR	High Flux Beam Reactor
HWMF	Hazardous Waste Management Facility
IAG	Interagency Agreement
IP	Industrial Park
Linac	Linear Accelerator
LIPA	Long Island Power Authority
LUCMP	*Land Use Controls Management Plan*
LU/IC	Land Use/Institutional Controls
mCi	milliCuries
MCL	maximum contaminant level
mRem	milliRem
MTBE	methyl tertiary butyl ether

NCP	*National Contingency Plan*
NEAR	Neighbors Expecting Accountability and Remediation at Brookhaven National Laboratory
NPL	*National Priorities List*
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O&M	operation and maintenance
ORISE	Oak Ridge Institute for Science and Education
OU	Operable Unit
pCi/L	picocurie(s) per Liter
pCi/g	picocurie(s) per gram
PCBs	polychlorinated biphenyls
PCE	tetrachloroethylene
ppm	part(s) per million
RA	Removal Action
RAO	Remedial Action Objective
ROD	Record of Decision
SCDHS	Suffolk County Department of Health Services
SCWA	Suffolk County Water Authority
SPDES	State Pollutant Discharge Elimination System
Sr-90	strontium-90
STP	Sewage Treatment Plant
SVOC	semivolatile organic compound
TAG	Technical Assistance Grant
TBC	Items “to be considered”
TCA	1,1,1-trichloroethane
TCE	trichloroethene
TVOC	total volatile organic compound
UST	underground storage tank
VOC	volatile organic compound
WCF	Waste Concentration Facility
WSB	Western South Boundary
µg/L	microgram(s) per liter

Glossary

Administrative Record: A file that contains the documents, including technical reports, which form the basis for selection of a final remedy and acts as a vehicle for public participation.

Area of Concern: A geographic area of BNL where there has been a release or the potential for a release of a hazardous substance, pollutant, or other contaminant. There are 30 areas of concern at BNL.

Closeout Report: A report that documents the completion of construction of the remedy and how it complies with the requirements of the remedial design plans, specifications, and the ROD. The report includes post excavation confirmatory sampling results.

Institutional Controls: Measures or restrictions established to prevent exposure of workers or the public to hazards. These may include the establishment of fencing, posting of signs, prevention of unplanned alteration of contaminant plume flow pathways, etc.

Interagency Agreement: A legal binding document established under the Comprehensive Environmental Response, Compensation, and Liability Act, that presents the framework for implementing the cleanup activities at a particular site. At BNL, the IAG was signed in 1992 by the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the New York State Department of Environmental Conservation.

Maximum Contaminant Level: A standard set by the U.S. Environmental Protection Agency, and the New York State Department of Environmental Conservation for contaminants in drinking water. These contaminants represent levels that the regulatory agencies believe are safe for people to drink. DEC standards often apply a safety factor and are more stringent than the Federal standards.

Operable Unit: Groups of areas within a site containing the same or similar contamination. The areas within one operable unit are not necessarily adjacent. BNL has six operable units.

PicoCurie Per Liter: A unit of measure of radioactivity per liter of water.

Record of Decision: Documents the decision by DOE and the regulators on a selected remedial action. It includes the responsiveness summary and a bibliography of documents that were used to reach the remedial decision. When the record of decision is finalized, the remedial design and construction can begin.

Brookhaven National Laboratory
Five-Year Review Report

1.0 Introduction

The purpose of this Five-Year Review is to determine whether the remedies implemented at Brookhaven National Laboratory (BNL) continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review Reports. In addition, Five-Year Review Reports identify issues found during the review, if any, and provides recommendations to address them.

The U.S. Department of Energy (DOE) prepared this Five-Year Review Report pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) §121 and the National Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

DOE interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) §300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

Brookhaven Science Associates (BSA), under contract with the DOE, manages and operates BNL. BSA's Environmental and Waste Management Services Division (EWMSD) and Environmental Restoration (ER) Projects Directorate conducted this Five-Year Review of the remedial actions implemented at the BNL site in Upton, New York under the direction of the DOE Remedial Project Manager. This report documents the results of the review.

This is the first sitewide Five-Year Review for the BNL site that includes all the Operable Units (OUs) and the Brookhaven Graphite Research Reactor (BGRR). A Five-Year Review was previously prepared but was focused specifically on the OU IV remedy at BNL (September 2003). In addition, Five Year Evaluation Reports were prepared for the Current and Former Landfills in 2001 and 2002 in accordance with New York State Part 360 requirements. The triggering action for this 2005 sitewide statutory review is initiation of the remedial action for OU I contaminated landscape soils, on July 18, 2000. The review is required because hazardous substances, pollutants, or contaminants at the site are above levels that allow for unlimited use and unrestricted exposure.

This first sitewide Five-Year Review includes an evaluation of all the Areas of Concern (AOCs) at BNL, except for the g-2 Tritium Plume (AOC 16T) and Brookhaven Linac Isotope Producer

(BLIP AOC 16K). Remedial actions for those AOCs will be presented in a Record of Decision (ROD) that is scheduled for submittal to the regulators in October 2006. Another decision document will be prepared for the High Flux Beam Reactor (HFBR). The second sitewide Five-Year Review will include all AOCs, including the g-2 Tritium Plume and BLIP.

2.0 Site Chronology

The BNL site is currently being addressed under six OUs covering 30 AOCs. The chronology in Table 1 first identifies general site information, and then breaks each OU down by major event. Table 2 presents each OU and Removal Action AOC.

3.0 Facility-Wide Background

3.1 Physical Characteristics

The BNL site is located in Upton, Suffolk County, New York, near the geographic center of Long Island. The BNL property approximates a square, 3 miles on each side, comprising an area of approximately 5,265 acres (about 8 square miles). The boundaries of BNL are either near or adjacent to neighboring communities. Approximately 150 people live in apartments and cottages on site, and many of the approximately 4,000 scientists and students who visit each year stay in the Lab's dormitories. The site's terrain is gently rolling, with elevations varying between 40 and 120 feet above mean sea level. The land lies on the western rim of the Peconic River watershed, with a tributary of the river rising in marshy areas in the northern part of the site.

3.2 Geology/Hydrogeology

BNL is underlain by unconsolidated glacial and deltaic deposits that overlie gently southward sloping, relatively impermeable, crystalline bedrock. The deposits are about 2,000 feet thick in central Suffolk County. The aquifer beneath BNL is comprised of three water-bearing units: the Upper Glacial, the Magothy, and the Lloyd aquifers. These units are hydraulically connected and make up a single zone of saturation with varying physical properties extending from depth of 45 to 1,500 feet below the land surface. These three bearing units are designated as a "sole-source aquifer" by the EPA and serve as the primary source of drinking water for Nassau and Suffolk counties.

3.3 Land and Resource Use

The site where BNL is located was formerly occupied by the U.S. Army as Camp Upton during World Wars I and II. Between the wars, the Civilian Conservation Corps operated the site. In 1947, the Atomic Energy Commission established BNL. The Laboratory was transferred to the Energy Research and Development Administration in 1975 and to the DOE in 1977. BNL is currently a federal facility that conducts research in physical, biomedical and environmental sciences and energy technologies.

The developed region of the site includes the principal BNL facilities which are near the center of the site on relatively high ground. These facilities comprise an area of approximately 900 acres, of which 500 acres were originally developed for Army use. Outlying facilities occupy approximately 550 acres and include an apartment area, agricultural field, former Hazardous Waste Management Facility (HWMF), Sewage Treatment Plant (STP), firebreaks, and former landfill areas.

Figure 1 provides the current land-use designations for the BNL site. This includes industrial use in the central portion of the site, with open space borders. A significant portion of land on the eastern portion of the site has been designated as the Upton Ecological Reserve. A small portion of the site is residential and agricultural. Further detail of the land use designations for specific remediation areas is identified in the BNL Land Use and Institutional Controls (LUIC) website (http://luic.bnl.gov/website/landcontrols/). These land use settings are projected to remain the same. These include:

- Soil Remediation Complete - Unrestricted Land Use (A)
- Soil Remediation Complete - Restricted Land Use (B)
- Capped/Controlled Contaminated Soils - Restricted Land Use (C)
- Known or Potentially Contaminated Soils, Remediation Pending - Restricted Land Use (D)
- Groundwater Contamination Areas - Restricted Groundwater Use (E)
- Radiological Facility, Decontamination & Demolition Pending - Restricted Land Use (F)

Table 1: Chronology of Site Events

General Site Information	
Site of future BNL serves as Army Camp Upton for World Wars I and II, operated by the Civilian Conservation Corps between wars	1917 – 1940s
Site transferred to the Atomic Energy Commission, BNL developed	1947
BNL transferred to the Energy Research and Development Administration	1975
BNL transferred to the Department of Energy	1977
BNL added to NYSDEC list of Inactive Hazardous Waste Sites	1980
BNL listed on EPA National Priorities ("Superfund") List	1989
DOE entered into Interagency Agreement with EPA and NYSDEC under CERCLA	1992
Operable Unit I	
Removal Action (RA) for "D-waste" tanks removal	1994
RA for Landfill capping	1995–1997
RA for South Boundary groundwater treatment system construction, and public water hookups	1996
RA for Chemical/Animal Pits and Glass Holes excavation	1997
ROD signed	1999
Completed excavating landscape soil; Closeout Report issued	2000, 2001
Completed excavating sludge from Building 811 underground storage tanks (USTs); Closeout Report issued	2001
Completed excavating soil and /pipeline associated with Building 650; Closeout Report issued	2002
Completed capping Ash Pit; Closeout Report issued	2003/2004
Completed excavating soil and reconstructed Upland Recharge and Meadow Marsh); Closeout Report issued	2003/2004
Completed excavating former Hazardous Waste Management Facility (HWMF) soil; Closeout Report issued	2005
Completed excavating Building 811 USTs/soils, Closeout Report issued	2005
Completed excavating former Chemical Holes residual surface soils; Addendum to Closeout Report issued	2005
Operable Unit II/VII	
Remedial Investigation (RI)/RA Report issued	1999
Evaluation of alternatives included under OU I Feasibility Study (FS)	NA
RA for BLIP Facility (AOC 16K) cap, drainage control, grout injection, and Closeout Report issued	1998/2002
Operable Unit III	
RA for Building 479 PCB-contaminated soil excavation	1992
RA for Building 464 mercury-contaminated soil excavation	1993
RA for South Boundary groundwater treatment system construction	1997
RA for High Flux Beam Reactor (HFBR) tritium plume groundwater treatment system	1997
RA for public water hookups	1996–1998
RA for cesspools/septic tanks completed, Closeout Report issued	1994–1999
RA for USTs completed, Closeout Report issued	1994–1999
RA for Carbon Tetrachloride groundwater treatment system construction	1999
RA for Industrial Park groundwater treatment system construction	1999
ROD signed	2000
Completed constructing Building 96 groundwater treatment system	2000
Completed constructing Middle Road groundwater treatment system	2001
Completed constructing low-flow pumping system for HFBR tritium plume	2001
Completed constructing Western South Boundary groundwater treatment system	2002
Completed constructing Chemical Holes Sr-90 groundwater treatment system (Pilot Study)	2003
Petition approved for shutdown of the Carbon Tetrachloride treatment system	2004
Completed constructing four remaining off-site groundwater treatment systems: Industrial Park East, North Street, North Street East, LIPA/Airport	2004
Completed constructing BGRR/Waste Concentration Facility (WCF) Sr-90 groundwater treatment system	2004
Completed excavating Building 96 PCB-contaminated soil; Closeout Report issued	2005
Explanation of Significant Differences (ESD) issued	2005
Building 96 Groundwater Treatment System Shutdown Petition Issued	2005

continued…

Table 1: Chronology of Site Events *(continued)*

Operable Unit IV	
RA for fence around Building 650 Sump outfall area soil	1995
ROD signed	1996
Completed constructing AS/SVE remediation system	1997
Petition approved for shutdown of AS/SVE remediation system	2000
Five-Year Review submitted to EPA and NYSDEC	2002
Petition for closure of AS/SVE Remediation System approved by EPA and NYSDEC; system dismantled	2003
Final Five-Year Review issued	2003
Operable Unit V	
RA for Imhoff Tanks	1995
ROD signed for Sewage Treatment Plant (STP)	2002
Completed excavation: STP soils; Completion Report issued	2003
RA for Peconic River sediment excavation on site; Completion Report issued	2004/2005
RA for Peconic River sediment excavation off site; Completion Report issued	2004/2005
ROD signed for Peconic River	2005
Closeout Report for Peconic River Phase 1 and 2 Remediation submitted to regulators for review	2005
Operable Unit VI	
RA for public water hookups	1996–1997
ROD signed	2001
Completed constructing EDB groundwater treatment system off site	2004
Brookhaven Graphite Research Reactor	
RA for BGRR primary cooling fans and equipment	1999
RA for pile fan sump	1999–2000
RA for above-grade ducts	2000–2002
RA for canal house and water treatment house	2001–2002
RA for coolers and filters	2002–2003
RA for BGD primary liner	2004
RA for fuel canal and subsurface soils	2005
ROD signed	2005

Notes
AOC = Area of Concern
AS/SVE = Air Sparging/Soil Vapor Extraction
BLIP = Brookhaven Linac Isotope Producer
BGD = below-ground duct
CERCLA = Comprehensive Environmental Response, Compensation and Liability Act
EPA = U.S. Environmental Protection Agency
ESD = Explanation of Significant Differences
FS = Feasibility Study
HWMF = Hazardous Waste Management Facility
IAG = Interagency Agreement
NYSDEC = New York State Department of Environmental Conservation
RA = Removal Action
RI = Remedial Investigation
ROD = Record of Decision
STP = Sewage Treatment Plant
USTs = underground storage tanks
WCF – Waste Concentration Facility

Table 2. Operable Unit (OU) AOCs

Category	AOC #	Description and Status
OU I (ROD approved)	AOC 1 (A,C,D,E,F,G,H,I)	Hazardous Waste Management Facility – complete except for Waste Loading Area
	AOC 1B	Spray Aeration Site – removal action complete
	AOC 2 (A,B,C,D,E,F)	Former Landfill Area – complete
	AOC 3	Current Landfill – complete
	AOC 2 and 3	Landfills Closure – removal action complete
	AOC 6	Buildings 650 Sump and Sump Outfall – complete
	AOC 8	Upland Recharge Area/Meadow Marsh – complete
	AOC 10A	Waste Concentration Facility – Tanks D-1, D-2, and D-3 – removal action complete
	AOC 10B,C	Waste Concentration Facility – Underground pipelines and Six A/B USTs - complete
	AOC 12	Underground Storage Tanks at Bldg. 445 – removal action complete
	AOC 23	Off-Site Tritium Plume (southern component) – complete
	Sub AOC 24E	Recharge Basin HS, Outfall 005 – complete
	Sub AOC 24F	New Stormwater Runoff Recharge Basin – complete
OUs II/VII (addressed in OU I ROD; approved)	AOC 10A,B,C	Waste Concentration Facility (Building 811) – complete
	AOC 16 (A,B,C,D,E,F,G,H,I,J, L,M,N,O,P,Q,S)	Aerial Radioactive Monitoring System Results – complete
	AOC 17	Area Adjacent to Former Low-Mass Criticality Facility – complete
	AOC 18	AGS Scrapyard ("Boneyard") – complete
	AOC 20	Particle Beam Dump, north end of Linac – complete
OU III (ROD approved)	AOC 7	Paint Shop – groundwater monitoring underway
	AOC 9	BGRR (groundwater) – treatment system operating
	AOC 10	Waste Concentration Facility (groundwater) – treatment system operating
	AOC 11	Building 830 Pipe Leak –complete; groundwater monitoring underway
	AOC 12	Underground Storage Tanks at Bldg. 830 – removal action complete
	AOC 13	Cesspools – removal action complete
	AOC 14	Bubble Chamber Spill Areas – groundwater monitoring underway
	Sub AOC 15A	Supply/Potable Wells 1, 2, 3, 4, 6, 7, 10, 11, 12
	Sub AOC 15B	Monitoring Well 130-02 – treatment system operating
	AOC 18	AGS Scrapyard (groundwater) – groundwater monitoring underway
	AOC 19	TCE Spill Area, Building T-111 – groundwater monitoring underway
	AOC 20	Particle Beam Dump, north end of Linac (includes Basin HT) – monitor and maintain per SPDES permit and *Natural Resource Management Plan* (NRMP)
	AOC 21	Leaking sewer pipes (sitewide, not investigated under other OU study areas) – groundwater monitoring underway
	AOC 22	Old Firehouse – no further action, per ROD
	Sub AOC 24A	Process Supply Wells 104 and 105 – treatment systems operating, groundwater monitoring underway
	Sub AOC 24B	Recharge Basin HP, Outfall 004 – monitor & maintain per SPDES permit & NRMP
	Sub AOC 24C	Recharge Basin HN, Outfall 002 – monitor & maintain per SPDES permit & NRMP

continued…

Table 2. Operable Unit (OU) AOCs *(continued)*

Category	AOC #	Description and Status
	AOC 25	Building 479 PCB soil removal complete, and groundwater monitoring underway
	AOC 26	Building 208 – removal action complete
	AOC 26A	Building 208 (groundwater) - groundwater monitoring underway
	AOC 26B	Former Scrapyard/Storage Area south of Bldg. 96 – treatment system operating
	AOC 27	Building 464 mercury soil removal complete, groundwater monitoring underway
	AOC 29	Spent fuel pool in HFBR and associated groundwater plume of tritium – treatment system on standby; groundwater monitoring underway
OU IV (ROD approved)	AOC 5 (A,B,C,D)	Central Steam Facility – treatment system decommissioned
	AOC 6	Reclamation Facility Interim Action – complete
	AOC 12	Underground Storage Tanks at Bldg. 650 – removal action complete
	AOC 21	Leaking Sewer Pipes (in study area) – complete
	Sub AOC 24D	Recharge Basin HO, Outfall 003 – complete
OU V – STP (ROD Approved)	AOC 4 (A,B,C,D,E)	Sewage Treatment Plant - complete
	AOC 21	Leaking sewer pipes (in the study area) – complete
	AOC 23	Off-site tritium plume (eastern component) – groundwater monitoring underway
OU V – Peconic River (ROD Approved)	AOC 30	Peconic River – cleanup on and off of BNL property complete
OU VI (ROD approved)	AOC 28	EDB groundwater contamination – treatment system operating
BGRR (ROD Approved)	AOC 9A	Canal – complete
	AOC 9B	Underground duct work – complete
	AOC 9C	Spill sites – underway
	AOC 9D	Pile Fan Sump – complete
g-2 and BLIP ROD	AOC 12	Underground Storage Tanks, Bldgs. 462, 463, 527, 703, 927, 931B – complete
	AOC 16K	Aerial Radioactive Monitoring System results – BLIP, Building 931B – removal action complete
	AOC 16R	Aerial Radioactive Monitoring System results – Nuclear Waste Management Facility, Building 830 – complete
	AOC 16T	Aerial Radioactive Monitoring System results - g-2 Source Area andTritium Groundwater Plume – Focused Feasibility Study under regulator review

Notes
AGS = Alternating Gradient Synchrotron
AOC = Area of Concern
BGRR = Brookhaven Graphite Research Reactor
BLIP = Brookhaven Linac Isotope Producer
HFBR = High Flux Beam Reactor
NRMP = Natural Resource Management Plan
ROD = Record of Decision
SPDES = State Pollutant Discharge Elimination System VOC = Volatile organic compounds

Because of chemical contamination in the Upper Glacial aquifer, public water hookups were provided by DOE for homes in the area south of BNL. However, eight known homeowners have elected not to connect to public water and continue to operate private wells. Annually, DOE formally offers those homeowners free testing of their private drinking water wells.

3.4 History of Contamination

Much of the environmental contamination at BNL is associated with past accidental spills and historical storage and disposal of chemical and radiological materials. These past operations, some of which may date back as far as the Army days, have caused soil and groundwater contamination that can be categorized into four main areas. These areas are 1) the groundwater contamination (primarily volatile organic compounds [VOCs]), ethylene dibromide [EDB], strontium-90 [Sr-90], and tritium), 2) soils contamination (primarily polychlorinated biphenyls [PCBs], metals, cesium-137 [Cs-137] and Sr-90) and landfills, 3) the Peconic River sediment contamination (primarily metals, and PCBs) and 4) the BGRR (primarily radioactivity). Contamination in the Peconic River and VOC groundwater contamination have extended off the BNL property. The most significant environmental concern is that the Lab lies above a sole-source aquifer that is used for drinking water purposes both on and off site. Brief descriptions of the nature of contamination associated with each OU and the BGRR covered under this Five-Year Review are as follows:

- OU I – Former landfills, disposal pits, and soils contaminated with metals such as mercury and lead, and radionuclides including Cs-137 and Sr-90; above- and below-ground leaking storage tanks; and VOC-contaminated groundwater such as 1,1-dichloroethane, on BNL property
- OU II/VII – Radiologically-contaminated soils on BNL property such as Cs-137. The AOCs in this OU were documented under the OU I and III RODs (except for BLIP [AOC 16K] which will be documented in a separate ROD)
- OU III – Groundwater contaminated with VOCs such as carbon tetrachloride, 1,1,1-trichloroethane (TCA), and tetrachloroethylene (PCE), and radionuclides such as tritium and Sr-90 on BNL property; and VOC-contaminated groundwater off of BNL property including PCE and carbon tetrachloride
- OU IV – Soil and groundwater contaminated with VOCs such as toluene and ethylbenzene, and semivolatile organic compounds (SVOCs) from former oil/solvent tank spill on BNL property
- OU V – Radiologically and metal-contaminated soil at the STP such as Cs-137, mercury, and silver; metal (mercury, silver, copper) and PCB-contaminated sediment in the Peconic River; and VOC contaminated groundwater including trichloroethene (TCE) on and off of BNL property
- OU VI – EDB-contaminated groundwater off of BNL property
- BGRR - Radiologically-contaminated soils, sumps, ducts, piping, and standing water including Cs-137 and Sr-90; and Sr-90 groundwater on the BNL site

Although not included under this Five-Year Review, another decision document will be prepared for the HFBR.

3.5 Initial Response

In 1980, the BNL site was placed on the NYSDEC list of Inactive Hazardous Waste Sites. In 1989,

BNL was also included on the EPA National Priorities List because of soil and groundwater contamination. Subsequently, EPA, DEC, and DOE entered into a Federal Facilities Agreement (also referred to as the Interagency Agreement, or IAG). While not formal IAG partners, the Suffolk County Department of Health Services (SCDHS) and the New York State Department of Health are also actively involved with BNL cleanup decisions. The IAG became effective in 1992, and it identified AOCs that were grouped into OUs to be evaluated for response actions. The IAG established the framework and schedule for characterizing, assessing, and remediating the site in accordance with the requirements of CERCLA. There are 30 AOCs and six OUs at the BNL site.

As noted in Table 1 in Section 2.0 above, prior to the approval of the RODs DOE used its removal action authority in many situations to help reduce risks to human health and the environment. In most cases, these actions were taken to address source areas of contamination. These activities include the closure/capping of landfills, fencing, tank removals, soils remediation, groundwater treatment, public water hookups, STP remediation, Peconic River sediment remediation, and response actions at the BGRR. In several cases, the removal action ended up being the final remedial action. These actions are documented in the RODs.

3.6 Basis for Taking Action

Summarized below for each OU are the nature of the contamination as well as the risks to human health and the environment.

Operable Unit I. Radioactively contaminated soil is the principal threat. In addition, several Removal Actions were conducted to address buried waste at several AOCs.

Soils: The former HWMF (AOC 1) contains most of the radioactively contaminated soil at BNL. The predominant radionuclide is Cs-137, which is the primary source of risk from direct exposure. Sr-90 is also present, and most of the contamination is at or near the surface although in some locations it extends to 12 feet below grade. Other contaminated soil areas include the Waste Concentration Facility (WCF, AOC 10) (which also contained leaking tanks), Building 650 sump and sump outfall (AOC 6), and several areas throughout the site that were the result of contaminated soils once used for landscaping purposes. The Former (AOC 2), Interim (AOC 2D), and Current (AOC 3) landfills, as well as the Glass/Chemical/Animal Holes (AOC 2B and 2C), received waste generated at BNL between 1917 through 1990. These disposal areas were unlined and had a direct impact on groundwater quality prior to their being capped or excavated in the mid 1990s. Contaminants at the Former Landfill Area include VOCs, metals such as mercury, and Sr-90.

The ash pits (AOC 2F), which once received ash and slag from a solid-waste incinerator located on the BNL site, have lead concentrations above cleanup goals. The Upland Recharge/Meadow Marsh Area (AOC 8) contained sediment with low levels of pesticides and metals below cleanup standards for human health but presented an exposure risk to eastern tiger salamanders, an endangered species in New York State.

Groundwater: The groundwater beneath the Former Landfill area contains VOCs and Sr-90, while the Current Landfill contains VOCs. Volatile organic compound contamination from these areas has migrated beyond the site's boundary.

Operable Unit II/VII. The principal threat is from radioactively contaminated soils.

Soils: Cs-137 is the major radiological contaminant of concern in soil where it can exceed specified risk or radiation dose limits. Cs-137 was found in the WCF soils as well as several areas identified from the aerial radioactive monitoring system results (i.e., landscaping soils [AOC 16S]). During the remedial investigation, no soil contamination at the landscape soils were found more than 2 feet below grade. Sr-90 soil contamination was found deeper than two feet at the WCF, as was tritium contamination in soil at the BLIP.

Groundwater: The BLIP (AOC 16K) contains an area of soil and groundwater contamination. Research operations have resulted in the activation of soil used for shielding. The primary contaminants of concern at this area are tritium and sodium-22. The threat results from the infiltration of rainwater through the contaminated soils, and the leaching of tritium and sodium-22 into the groundwater at concentrations that exceed drinking water standards.

Operable Unit III. Groundwater contamination is the most significant concern; however, there are a few minor soil AOCs.

Groundwater: The groundwater beneath BNL and beyond the Laboratory's boundary is a sole source of drinking water, therefore groundwater contamination is considered the greatest potential risk to human health and the environment. Groundwater on and off of BNL property is contaminated with VOCs such as TCA, PCE, and carbon tetrachloride. Tritium and Sr-90 are also present above the drinking water standards on the BNL site. There is no radiological contamination off of BNL property that exceeds drinking water standards. The potable drinking water supply wells on and off of the BNL site are currently not impacted, nor are they expected to be impacted from the contamination. There are eight known homeowners who continue to use their private wells for drinking water purposes; however, DOE offers free annual testing of their well water.

Soils: PCB-contaminated soils above the New York State Technical and Administrative Guidance Memorandum (TAGM) cleanup levels were found at the Building 96 former Scrapyard (AOC 26B). Other smaller soil-contaminated areas included mercury at Building 464 (AOC 27) and PCBs at Building 479 (AOC 25).

Operable Unit IV. Soil and groundwater are the concerns.

Groundwater: VOCs and SVOCs such as benzene, toluene, and ethylbenzene from an historical oil/solvent spill contaminated the groundwater at this OU. BNL potable wells are located upgradient of this area. Strontium-90 was released to groundwater at the Building 650 Sump Outfall and the plume is located in the central portion of the site.

Soil: VOCs and SVOCs are also present in the soils from the spill. Radiological contamination has been identified at the Building 650 Sump Outfall.

Operable Unit V. Radioactively and metal-contaminated soil, and metal and PCB-contaminated river sediment are the principal threats.

Soil/Sediment: The STP berms (AOC 4) presented concern due to potential impacts to future on-

site residents from Cs-137 and mercury. In addition, concentrations of mercury and PCBs in fish may have posed a health hazard to people consuming fish taken from certain locations on the Peconic River (AOC 30). Sediment within certain depositional areas of the Peconic River was contaminated with mercury, silver, and copper, and posed a potential ecological concern. Surface sediment in depositional areas up to 1.5 miles downstream of the STP contained PCB aroclor-1254. Trace amounts of Cesium-137 were co-located in the sediment, but did not drive the risk.

Groundwater: The primary contaminants in the groundwater on and off of the BNL site include trichloroethene (TCE) and tritium. Tritium has not been detected above the drinking water standards, and TCE concentrations are slightly above the standards.

Operable Unit VI. Groundwater contamination is the primary threat.

Groundwater: The pesticide EDB is the contaminant of concern (AOC 28). It has been found in groundwater on and off of BNL property significantly above the drinking water standard of 0.05 µg/L.

BGRR

Structures and Soils: There are several radiologically contaminated structures at various locations within the BGRR complex (AOC 9). These include the graphite pile and surrounding biological shield, contaminated concrete within the fuel-handling system's deep pit and fuel canal (AOC 9A), and contaminated steel and concrete within the belowground ducts (BGD, AOC 9B). Additionally there are isolated pockets of contaminated soils adjacent to the BGD secondary cooling air bustle and expansion joints, fuel canal outer walls and construction joint, the reactor building pipe trench, and the reactor building drains. Most nonradiological hazardous materials associated with the BGRR was removed through previous interim stabilization measures. Isolated pockets of nonradiological hazardous material contamination are present within the reactor building pipe trench, and within embedded drain lines. Hazardous materials intrinsic to construction materials, such as floor tiles, paint, and insulating materials, remain within the reactor building.

Groundwater: Groundwater contaminated with Sr-90, included under OU III, is present beneath the BGRR complex, at concentrations significantly above the 8 pCi/L drinking water standard. The Sr-90 contamination has not been detected off of the site above the standard.

4.0 Remedial Actions

4.1 Remedy Selection

As of the date of this report, seven Records of Decision have been signed at BNL. The first was signed in 1996 and the last two were signed in early 2005. The seven RODs are:

1. OU I - Radiological contaminated soils on the BNL site
2. OU III - Groundwater on and off of the BNL site
3. OU IV - Soil and groundwater on site
4./5. OU V - STP and the Peconic River (two RODs)
6. OU VI - EDB in groundwater off of the BNL site
7. BGRR - Radiological contaminated structures and soil on site

Individual site locations are indicated in Figure 2. A ROD for the remaining OU, the g-2 Tritium Plume, BLIP, and USTs (AOCs 16T, 16K, and 12), is still pending and is due for submittal to the regulators in the fall of 2006. Brief descriptions of the ROD remedial action objectives and the major remedy components appear below.

Operable Unit I ROD, signed August 1999 (BNL 1999)

- Objectives are to prevent or minimize:
  - Leaching of contaminants (radiological and chemical) from soil into the groundwater
  - Migration of contaminants present in surface soil via surface runoff and windblown dust
  - Human exposure including direct external exposure, ingestion, inhalation, and dermal contact, and environmental exposure to contaminants in the surface and subsurface soils
  - Uptake of contaminants present in the soil by ecological receptors
- OU I Remedy components:
  - Excavate soil and sediment that are radiologically and chemically contaminated above the selected cleanup goals at the former HWMF, WCF, Building 650 sump and sump outfall, and the Chemical/Animal/Glass Holes, and dispose of off the BNL site at an approved facility. Reconstruct wetlands at the former HWMF.
  - Remove out-of-service facilities, tanks, piping, and equipment at the former HWMF and WCF.
  - Install soil caps to address metal contamination at ash pits.
  - Excavate chemically contaminated sediment from the Upland Recharge/Meadow Marsh Area and dispose of off the BNL site at an approved facility. Reconstruct wetlands and monitor.
  - Implement long-term institutional controls and monitoring to ensure that planned uses are protective of public health.
  - All of the previous removal actions that were implemented, such as landfill capping, waste and soil excavation, groundwater pump and treat systems, were selected as final remedies under the ROD.

Groundwater contamination associated with the Former Landfill Area and off-site groundwater associated with other Operable Unit I AOCs was addressed in the OU III ROD (BNL 2000a). An evaluation of remedial alternatives for contaminated soil and groundwater associated with the BLIP facility (AOC 16K) was completed. The final remedy for contaminated soils at BLIP will be documented in a ROD scheduled for submittal to the regulators in the fall of 2006.

Operable Unit II Decisions

Remedial actions for the OU II AOCs are documented in the OU I ROD (BNL 1999) and OU III ROD (BNL 2000a).

Operable Unit III ROD, signed June 2000 (BNL 2000a)

- Objectives are to:
  - Meet the drinking water standards (i.e., maximum contaminant levels [MCLs]) in groundwater for VOCs, Sr-90, and tritium.

- Complete cleanup of the groundwater in a timely manner. For the Upper Glacial aquifer, this goal is 30 years or less.
- Prevent or minimize further migration of VOCs, Sr-90, and tritium in groundwater.

- OU III Remedy Components:
  - For VOCs – Install treatment systems on and off of BNL property at the Long Island Power Authority (LIPA) right-of-way, North Street, Airport, North Street East, Industrial Park East, Middle Road, and western south boundary. All of the previously implemented VOC removal actions (including treatment systems at the south boundary and Industrial Park) were selected as final remedies under the OU III ROD.
  - For tritium (AOC 29) – Institute contingency plans to reactivate the Princeton Avenue pump and recharge system, and low-flow groundwater extraction of high tritium concentrations with approved off-site disposal of the water.
  - For Sr-90 - Install treatment systems using ion exchange at the Chemical Holes and the BGRR/WCF plumes. Prior to implementation, perform a pilot treatability study to evaluate the effectiveness of extraction and treatment, and modify the remedy, if needed.
  - Magothy aquifer – Perform additional characterization and determine the need for a remedy. If a remedy for the Magothy is necessary, either the OU III ROD would be modified or another decision document would establish the selected action.
  - The previous removal action that was implemented for public water hookups was selected as a final remedy under the ROD.
  - Groundwater monitoring program to monitor and verify the cleanup over time.
  - Source Areas - Source removal system at Building 96 for VOCs in groundwater and PCBs in soil, remediation of groundwater at the carbon tetrachloride spill area, and removal of Building 830 USTs (AOC 12).
  - Deferred Decisions – The final remedy for potential source areas such as the Building 96 geophysical anomalies (AOC 26B) will be document in a subsequent ROD (see OU III ESD below). The final remedy for AOC 9D, the Pile Fan sump, was documented in the BGRR ROD.

<u>Operable Unit III Explanation of Significant Differences, signed May 2005 (BNL 2005a)</u>

- Remedy Components:
  - Magothy aquifer - Add two Magothy aquifer extraction wells off of BNL property in addition to the three wells already installed. Meet drinking water standards within 65 years.
  - Sr-90 – Continue to operate the existing pilot study at the Chemical Holes and meet the drinking water standards within 40 years. Install an ion exchange treatment system for the BGRR/WCF plume, and meet the drinking water standards within 70 years.
  - Building 96 Scrapyard – No further action for the geophysical anomalies.
  - Institute long-term institutional controls and monitoring to ensure that planned uses are protective of public health.

Operable Unit IV ROD, signed March 1996 (BNL 1996)

- Objectives are to restore the groundwater quality at the most contaminated portion of the AOC 5 plume to MCLs or background levels, and prevent or minimize:
  - Leaching of contaminants (radiological and chemical) from the soils into the groundwater
  - Volatilization of contaminants from surface soils into the ambient air
  - Migration of contaminants present in surface soil via surface runoff and windblown dust
  - Human exposure including ingestion, inhalation, and dermal contact, and environmental exposure to contaminants in the surface and subsurface soil and groundwater
  - Uptake of contaminants present in the soil and/or groundwater by plants and animals

- OU IV Remedy Components:
  - Treat chemically contaminated soil in the vadose zone of the spill area (AOC 5A) and the fuel unloading area (AOC 5D) using soil vapor extraction.
  - Treat groundwater at the most contaminated portion of the spill area using soil vapor extraction and air sparging.
  - Use an engineering enhancement option for the groundwater if soil vapor extraction and air sparging alone will not achieve the desired performance levels.
  - As an Interim Action, install a fence around the radiologically contaminated soil at Building 650 Sump and Sump Outfall area with institutional controls and monitoring. The final remedy for these soils is documented in the OU I ROD.

Operable Unit V Sewage Treatment Plant ROD, signed January 2002 (BNL 2001a)

- Objectives are to protect public health and the sole source aquifer, continue to monitor the groundwater, and to prevent or minimize:
  - Migration of contaminants present in surface soil via surface runoff, windblown dust
  - Human and environmental exposure to contaminants in surface and subsurface soil
  - Potential for uptake of contaminants present in the soil by ecological receptors
  - Potential for migration of contaminants (radiological and chemical) from the soil to groundwater
  - Reduce the levels of contamination in the sand filter beds (AOC 4B)/berms and adjacent areas

- OU V STP Remedy Components:
  - Excavate radiologically and chemically contaminated soil at the sand filter beds and berms, firing range berms, and the sludge drying beds, and dispose of off of BNL property at an approved facility.
  - Remove sludge from manholes along a retired section of the sanitary sewer line leading to the STP.
  - Monitor the groundwater for VOCs and tritium.
  - A previously implemented removal action for the Imhoff Tank is selected as the final remedy (AOC 4C).

- Implement institutional controls on BNL property such as preventing the installation of pumping wells that may interfere with groundwater monitoring. Implement Suffolk County's Sanitary Code regarding limitations of private well installations.
- Any sale or transfer of BNL property will meet the requirements of 120(h) of CERCLA to ensure that future users are not exposed to unacceptable levels of contamination.

Operable Unit V Peconic River ROD, signed January 2005 (BNL 2004a)

- Objectives are to:
  - Reduce site-related contaminants (e.g., mercury) in sediment to levels that are protective of human health.
  - Reduce or mitigate, to the extent practicable, existing and potential adverse ecological effects of contaminants in the Peconic River.
  - Prevent or reduce, to the extent practicable, the migration of contaminants off the BNL property.

- OU V Peconic River Remedy Components:
  - The response actions selected in the removal actions for sediment on BNL property and off of BNL property constitute the final remedy for the Peconic River. These include removal and disposal of mercury-contaminated sediment above agreed upon cleanup levels from designated depositional areas on and off of BNL property.
  - Implement a monitoring program to demonstrate the effectiveness of the cleanup. Near-term monitoring results will establish the basis for the long-term monitoring program. The program includes monitoring for methyl mercury in the water-column, sediment sampling, and fish sampling on and off of BNL property.

Operable Unit VI ROD, signed March 2001 (BNL 2000b)

- Objectives are to:
  - Meet the drinking water standards (i.e., MCLs) for EDB in groundwater (0.05 µg/L)
  - Complete cleanup of the groundwater in a timely manner. For the Upper Glacial aquifer, this goal is 30 years or less.
  - Prevent or minimize further migration of EDB in groundwater vertically and horizontally.
- OU VI Remedy Components:
  - Install a treatment system to extract EDB from the groundwater with subsequent treatment via activated carbon filtration.
  - The previous removal action that was implemented for public water hookups was selected as a final remedy under the ROD.
  - Install groundwater monitoring program to monitor and verify the cleanup over time.
  - Implement institutional controls on the BNL property to prevent use of contaminated groundwater in the OU VI area, as well as continued implementation of Suffolk County Sanitary Code Article 4 that prohibits the installation of additional residential wells where public water mains exist.

BGRR ROD, signed March 2005 (BNL 2005b)

- Objectives are to:
  - Ensure protection of human health and the environment, without undue uncertainties, from the potential hazards posed by the radiological inventory that resides in the BGRR complex.
  - Use the As Low As Reasonably Achievable (ALARA) principle, while implementing the remedial action.
  - Following completion of the remedial activities, implement long-term monitoring, maintenance, and institutional controls to manage potential hazards to protect human health and the environment.
- BGRR Remedy Components:
  - Remove the BGD primary liner.
  - Remove a portion of the fuel canal outside the structural footprint of the reactor building. Remove accessible subsurface contaminated soil in the vicinity of the fuel canal, BGD expansion joint #4, and the secondary cooling air bustle.
  - Isolate the BGD and demolish the instrument house.
  - Install water infiltration control and monitoring system for remaining structures and subsurface contaminated soil.
  - Remove the graphite pile and biological shield.
  - Complete final status surveys to document that cleanup objectives are met and to document final conditions.
  - Develop and implement land use and institutional controls that include routine inspection and surveillance of the BGRR complex, maintenance and upkeep of Building 701 and surrounding water infiltration control system, and reporting requirements to ensure that planned uses are protective of public health.
  - Submittal of an annual certification to NYSDEC that institutional and engineering controls are in place, are unchanged from the previous certification and nothing has occurred that would impair the ability of the control to protect public health and the environment.
  - All of the previous removal actions that were implemented prior to the ROD signing, such as removal and disposition of accumulated contaminated water, pile fan sump and soils, above ground ducts, canal and water treatment house, accessible contaminated soils, and exhaust cooling coils and filters, were selected as final remedies under the ROD.

4.2 Remedy Implementation

With the exception of the OU I former HWMF Waste Loading Area and the BGRR, all soil and groundwater remedies for the seven signed RODs at the site have been implemented. This includes the excavation and approved off-site disposal of all contaminated soil, sediment, and tanks, as well as the installation and operations initiated for all groundwater treatment systems. A chronology of the previous removal actions undertaken for each OU, and post-ROD remedial actions, are presented in Table 1 (see Section 2.0). A brief summary of the status of remedy implementation since the signing of each ROD is identified below:

Operable Unit I: Excavation and off-site disposal of radiological contaminated soil was initiated in 2000 with the landscape soil (approximately 2,800 cubic yards), followed by the Building 650

Sump and Sump Outfall (approximately 1,800 cubic yards), and Upland Recharge/Meadow Marsh (approximately 500 cubic yards). In 2005, removal of the former HWMF (approximately 13,000 cubic yards), Building 811 soil (approximately 4,000 cubic yards), and former Chemical Holes residual surface soil (approximately 4,000 cubic yards) was completed. Of the total contaminated soil volume, approximately 24,000 cubic yards is being disposed of at Envirocare of Utah, and 2,500 cubic yards were disposed of at Niagara Falls Landfill Facility. (Note that at the Chemical/Animal/Glass Holes an additional approximately 11,000 cubic yards were excavated in 1997 as a removal action prior to the ROD being signed.) The ash pits were capped with a soil cover to prevent direct contact risks in 2003, and the removal and disposal of the Building 811 USTs was completed in 2005. The Oak Ridge Institute for Science and Education (ORISE), an independent contractor to DOE, verified the cleanup effort at these radiological contaminated soils areas. Closeout reports were prepared for the landscape soil, Building 650 and Sump Outfall, Upland Recharge/Meadow Marsh, the former HWMF, Building 811 soil, and an addendum to the existing Chemical Holes Closeout Report was also prepared.

As noted in the *Final Closeout Report for Area of Concern 16 Landscape Soils* (BNL 2001b), the excavation of the landscape soil in 2000 indicates that the potential exposure to workers and future site residents is much less than the 15 milliRem (mRem)/year criteria. The residual mean concentrations of Cs-137 are below the current residential goal of 7 picoCuries per gram (pCi/g). As a result, these areas do not require postings or further institutional controls.

Operable Unit III: Following approval of the OU III ROD in June 2000, eight groundwater treatment systems were designed and installed between 2000 and 2005 both on and off of the BNL property. The Sr-90 system for the BGRR/WCF plume was the last one installed in 2005. These treatment systems were installed to address VOC and Sr-90 groundwater contamination. The performance of these systems in meeting the overall groundwater cleanup goals is evaluated in the annual *BNL Groundwater Status Report*. Through 2004, approximately 4,800 pounds of VOCs were removed from the aquifer (approximately 20 percent of the overall mass removal goal). This includes approximately 300 pounds and 35 pounds from OU I and IV, respectively. In accordance with the ROD, several low-flow extraction events were performed between 2000 and 2001 for the high-concentration segment of the HFBR tritium plume. Approximately 100,000 gallons of tritium-contaminated water were pumped from the aquifer and disposed of off-site at an approved facility. Contingency remedies continue to remain in place for this tritium plume. The regulators approved Petitions for Shutdown of the cabon tetrachloride and Building 96 treatment systems in 2004 and 2005, respectively. These systems were subsequently turned off and placed in standby mode.

Between 1999 and 2005, approximately 2,200 cubic yards of PCB-contaminated soil from the Building 96 former Scrapyard area were excavated and disposed of off site. This was accomplished in accordance with the ROD to reduce the direct contact risk from this area.

In accordance with the OU III ESD approved in 2005, two additional Magothy aquifer groundwater extraction wells were installed to address VOC contamination at two locations beyond the site boundary.

Operable Unit IV: In accordance with the March 1996 OU IV ROD, a groundwater treatment system was installed in 1997 to remediate VOC and SVOC soil and groundwater contamination at a former oil spill area. A CERCLA Five-Year Review performed for OU IV in 2003 (BNL 2003a) found that the remedy was very effective in remediating soil and groundwater contamination. The system met its cleanup objectives and the regulators approved its dismantlement in 2003.

Operable Unit V: Following issuance of the STP ROD (BNL 2001a), the contaminated soil at the plant was excavated and disposed of off-site in 2003 and a closeout report was issued (BNL 2004d). Prior to issuance of the Peconic River ROD (BNL 2005b), the excavation of on-and off-site contaminated sediments in the River was performed under the authority of a Removal Action. The closeout report for the Peconic River Phases 1 and 2 (BNL 2005c) has been issued.

Operable Unit VI: In 2004, a groundwater treatment system was installed in accordance with the ROD and began operations to address the plume of EDB located beyond the site boundary. This is the last of the planned systems installed beyond the site property. Per the OU III and VI RODs, DOE continues to offer homeowners not connected to public water free annual testing of their private wells.

BGRR: All of the cleanup actions performed to date at the BGRR have been through removal actions. Prior to the ROD approval in 2005, recent canal cleanup activities were performed as a Removal Action. The remaining cleanup actions at the BGRR, such as removal of the pile and bioshield, and the final engineered cap, will be performed as remedial actions under the ROD (BNL 2005b).

Groundwater Monitoring: An essential component of the groundwater remediation program is continued monitoring of the groundwater to ensure the cleanup is progressing as planned. The effectiveness of the groundwater remediation systems performance is evaluated monthly, quarterly, and annually. Changes are made, as necessary, to the treatment systems and to the monitoring programs to help ensure meeting drinking water standards within 70 years for the BGRR/WCF Sr-90 plume, within 65 years for the Magothy aquifer, within 40 years for the Chemical Holes Sr-90 plume, and within 30 years in the Upper Glacial aquifer.

Property Access: Seven access agreements are currently in place with the county, town, local utility, college, and private landowners. These agreements enable BNL to perform groundwater remediation activities for contamination that has migrated beyond the property boundary of BNL. The terms of these agreements must be adhered to by BNL, such as maintaining adequate liability insurance, and in some cases, making annual monetary payments.

4.3 System Operations/Operation and Maintenance

All 16 planned groundwater treatment systems have been constructed. One system has met its cleanup goals and was dismantled (OU IV), three systems are in standby mode and will be restarted if needed (HFBR Tritium, Carbon Tetrachloride, and Building 96 systems), and 12 systems are actively operating on and off of BNL. The first systems became operational in January 1997, the last coming on line in mid 2005. Three additional groundwater extraction wells are currently in standby mode. The requirements for ongoing operation and maintenance (O&M) as well as performance monitoring frequencies of these systems are identified in the O&M manuals.

Routine surveillance and inspection of these systems is performed by BNL personnel. Maintenance on the systems and the treatment wells is performed using BNL resources as well as contracted well drilling support. Preventive maintenance is performed on each system, in addition to as-needed repairs.

Groundwater is extracted from a total of 57 wells. Average individual extraction well flow rates range from approximately 5 gallons per minute (gpm) for the Sr-90 systems to up to150 gpm for the VOC systems. System treatment for VOCs consists primarily of air stripping or carbon adsorption. Ion exchange is the treatment method for the Sr-90 groundwater contamination. To monitor system performance, the influent, midpoint (if appropriate), and effluent are routinely sampled by BNL personnel and sent to off-site analytical labs for analysis. Treated water from the systems is discharged to the Upper Glacial aquifer via recharge basins, injection wells, or dry wells. New York State Pollutant Discharge Elimination System (SPDES) discharge equivalency permit requirements are met. Problems experienced with the treatment systems, as well as adjustments made, include the following:

- Building 96 System: Condensate buildup (primarily in the winter) in the air piping that transfers the VOC-contaminated vapors to the carbon treatment vessels results in a buildup of water in the piping. Resolution: BNL installed a valve at a low point in the building to periodically collect the water for processing.
- Iron buildup on the screens of the extraction wells, recharge wells, and recirculation wells can cause high pressure or water level alarms and shut down the system. Resolution: BNL has increased the frequency of well redevelopment.
- Middle Road and Chemical Holes Systems: Two instances of building floods occurred due to inadequate automatic controls on the pumping system. Resolution: BNL installed additional controls such as high-level float switches wired directly to the electric panel, notification, and automatic shutdown for use of manual/hand system operation mode.
- Chemical Holes System: Frequent high-level, low-level, and pressure shutdown alarms in the Chemical Holes Sr-90 treatment system holding tanks and pumps result in automatic shutdown and excess downtime for the system. Resolution: BNL redesigned process piping to bypass the holding tanks, and uses only the extraction well pump to process the water.
- Chemical Holes System: Early breakthrough of the UOP A51 zeolite resin for the Chemical Holes Sr-90 treatment system resulted in significantly increased cost and waste generation. Resolution: BNL performed a column study that identified a more cost-effective, naturally occurring zeolite resin, clinoptilolite. The performance of this zeolite is currently being monitored.

The annual O&M costs for several of the treatment systems over the past 4 years are as follows:

Table 3: System O&M Costs for FY 2001 to 2004

	($ in K)				
System	FY 2001	FY 2002	FY2003	FY 2004	Comments
OU I South Boundary	160	185	151	133	Air stripping
OU III South Boundary	144	168	168	125	Air stripping. One well placed on standby 10/03.
OU III Industrial Park	394	256	317	237	Uses in-well air stripping with vapor phase carbon treatment, with recirculation wells.
OU III Middle Road	NA	225	145	120	Air stripping. Two wells placed on standby 10/03.
OU III Carbon Tetrachloride	295	422	205	111	Carbon treatment. FY02 included additional characterization. System pulse-pumped and

					placed in standby mode 8/04.
OU III Western South Boundary	NA	NA	129	80	Air stripping.

The largest components of the annual O&M cost for the treatment systems are electric, system sampling and analysis, maintenance, and spent carbon or ion exchange resin disposal. Fiscal year 2005 will be the first full year of O&M for the liquid-phase carbon treatment systems off of BNL property. First year costs for these systems are not shown since they are currently being reconciled due to the transition of charge accounts to BNLs Long-Term Response Actions organization.

5.0 Progress since the Last Review

This is the first Five-Year Review for the BNL site that covers all the OUs. A previous Five-Year Review (BNL 2003a) focused specifically on OU IV. The protectiveness statement from the OU IV Five-Year Review is as follows:

> *"The remedies have been, and are expected to be, protective of human health and the environment upon attainment of soil and groundwater cleanup goals, remediation and natural attenuation. In the interim, exposure pathways that could result in unacceptable risks are being controlled and institutional controls are preventing exposure to, or the ingestion of, contaminated soil and groundwater. All threats at the site have been addressed through the installation of fencing and warning signs, and the implementation of institutional controls, however, long-term protectiveness of the remedial action will be verified by obtaining additional groundwater samples to fully evaluate potential migration of the strontium-90 plume downgradient from the source area. Current data indicate that the strontium-90 plume remains in OU IV and that the remedy is functioning as required to achieve groundwater cleanup goals."*

Table 4 shows the status of the actions from the 2003 OU IV Five-Year Review.

Table 4: Actions Taken Since the OU IV Five-Year Review

Recommendations/ Follow-up Actions	Responsible Party	Milestone Date	Action Taken and Outcome	Action Date
Obtain approval from EPA and NYSDEC on the petition for the Air Sparging/Soil Vapor Extraction (AS/SVE) system closure.	BNL	July 2003	Approval received and system was dismantled 12/03.	July 2003
Continue monitoring the radiologically contaminated groundwater near the Building 650 Sump and Outfall.	BNL	Ongoing	Monitoring continues. Results of monitoring data are in *2004 Groundwater Status Report*.	Ongoing
Continue monitoring select wells downgradient of the AS/SVE system and include in the EMP (*Environmental Monitoring Plan*) under the Sitewide and Facility Monitoring Programs.	BNL	Monitoring ongoing; 1/04 for EMP	Most monitoring changes have been implemented. The 1/06 EMP will document the changes.	December 2005
Complete excavation of radiologically contaminated pipe between Building 650 and the Sump Outfall (OU I).	BNL	July 2002	Excavation complete.	July 2002
Complete preparation of the Building 650 Sump and Outfall Closeout Report, submit to regulators (OU I).	BNL	July 2002	Closeout report issued to regulators.	July 2002

Recommendations/ Follow-up Actions	Responsible Party	Milestone Date	Action Taken and Outcome	Action Date
Complete characterization and remediation of the lead-contaminated soils at the stormwater outfall at the Central Steam Facility (not under CERCLA nor part of OU IV ROD).	BNL	NA	Report summarizing the characterization results and evaluating cleanup options submitted to regulators in 2/04. Response pending.	TBD

6.0 Five-Year Review Process

6.1 Administrative Components

The activities scheduled for conducting this Five-Year Review included regulator and community notification, site inspections, interviews with stakeholders and regulatory officials, development of the Five-Year Review Report including review by DOE, EPA, NYSDEC, and SCDHS, and a briefing on the results to the Community Advisory Council (CAC) and Brookhaven Executive Round Table (BER). The review was led by BNL's EWMSD Long-Term Response Actions Group. The Five-Year Review team consisted of:

- BNL staff – W. Dorsch, V. Racaniello, J. Burke, M. Hauptmann, T. Burke, R. Howe, L. Hill, S. Kumar, J. D'Ascoli, F. Petschauer, T. Daniels, and K. Robinson
- DOE staff – G. Penny, R. Rimando, J. Carter, and T. Kneitel
- Regulatory staff – D. Pocze (EPA), J. Lister (DEC), and S. Robbins (SCDHS)

The team included Hydrogeologists and Community Involvement Coordinators.

6.2 Community Notification and Involvement

A Communications Plan for the Five-Year Review was prepared and distributed to the project team, including the regulatory agencies, on March 15, 2005. The plan identifies specific outreach activities to be conducted, such as initial notification, interviews, report updates, and report issuance/notification.

An initial notification announcement was published in *Newsday* and *Suffolk Life* newspapers March 23, 2005 and March 30, 2005, respectively. It informed the public of the start of the review, as well as the purpose, schedule for completion, and how to contact DOE for more information. A copy of the announcements is available at http://www.bnl.gov/erd/5YearReview/InitialFive-YearPublicNotice.pdf. The CAC and BER were briefed on the start of the Five-Year Review on March 10, 2005 and March 23, 2005, respectively. The EPA Technical Assistance Grant (TAG) recipient for BNL, Neighbors Expecting Accountability and Remediation at Brookhaven National Laboratory (NEAR), was verbally informed of the review initiation. In addition, an announcement in the BNL weekly *Bulletin* and a BNL web site update were made to inform the BNL employees and the community that the Five-Year Review was being conducted (http://www.bnl.gov/bnlweb/pubaf/bulletin/2005/bb041505.pdf and http://www.bnl.gov/erd/).

Members of the CAC were polled during the May 12, 2005 meeting to get feedback on whether the Laboratory provided adequate information on the cleanup activities and if CAC members felt they had an effect on cleanup decisions. The results indicate that the CAC felt sufficiently informed of the cleanup progress and many believed the CAC had an impact on the cleanup. The survey is included as Attachment 5.

Prior to issuance of the Five-Year Review Report to the regulators for their review, a verbal update of the conclusions and recommendations was provided during an IAG teleconference on June 30, 2005. A briefing was also provided to the BER and CAC on July 13, and 14, 2005, respectively.

Following regulator review/concurrence and EPA concurrence on the final protectiveness determination, the community will be notified that the Five-Year Review was completed and it will be made available to the public. A public notice will be issued in *Newsday* and *Suffolk Life* at that time. The notice will include a brief summary of the results, the protectiveness statements, post-ROD information repository locations where the report is available for viewing, and the timeframe of the next Five-Year Review. These repositories are:

- BNL Research Library, Upton, NY
- EPA Region II Office, New York City, NY

The CAC and BER will be briefed on any changes to the report's conclusions and recommendations as a result of regulator review. The Report (or a summary of the Report) will also be added to the BNL website.

6.3 Document Review

The Five-Year Review consisted of a review of relevant documents including the following:

- Records of Decision for OUs I, III, IV, V (two), VI, and BGRR
- *OU III ESD* (BNL 2005a)
- Annual groundwater status reports (e.g., BNL 2005d)
- Annual and five-year landfill reports (e.g., BNL 2001c and BNL 2002)
- Closeout/Completion reports for soil (BNL 2005e) and BGRR (BNL 2005b) cleanup projects
- *OU IV Five-Year Review Report* (BNL 2003a)
- O&M manuals for the groundwater treatment systems
- *BNL Land Use Controls Management Plan* (BNL 2005g)
- *EPA Five-Year Review Guidance* (EPA 2001)

As noted in Section 4.1 above, the remedial action objectives for the projects are identified in the RODs and the OU III ESD.

6.4 Data Review

This section provides a brief summary review of analytical data and trends for each OU and the BGRR over the past 5 years. Trends for key groundwater monitoring wells by plume over the last several years are provided in Attachment 1. A detailed discussion of the status of the groundwater plumes and the progress of the 16 groundwater remediation systems is provided in the *2004 BNL Groundwater Status Report* (BNL 2005d—see Attachment 2 for the CD version or http://webeims.b459.bnl.gov/gw_home/gw_home.asp).

In 2004, 652 pounds of VOCs were removed from the aquifers by the treatment systems. To date, approximately 4,800 of the estimated 25,000 to 30,000 pounds of VOCs in the aquifer have been removed, and over 8 billion gallons of groundwater have been treated. The startup of the OU III Chemical Holes Sr-90 system in 2003 has resulted in 1.27 milliCuries (mCi) of Sr-90 being removed from the Upper Glacial aquifer.

Figure 3 identifies the location of the 16 groundwater treatment systems. Table 5 provides a summary of the treatment system status through 2004.

Table 5: Groundwater Treatment System Status

Operable Unit and System	Type	Target Contaminant	No. of Wells	Years of Operation	Recharge Method	Lbs VOCs removed (2004 / Cumulative)
Operable Unit I						
South Boundary	P & T (AS)	VOC	2	8	basin	16 / 313
Operable Unit III						
South Boundary	P & T (AS)	VOC	7	7	basin	172 / 2,276
HFBR Pump and Recharge	Pump and recirculate	Tritium	3	Standby: 7	basin	NA / 180
Industrial Park	Recirc./in-well (AS/carbon)	VOC	7	5	in-well	80 / 838
*Carbon Tet	P & T (carbon)	VOC	3	Standby: 5	basin	7 / 348
**Building 96	Recirc. well (AS/carbon)	VOC	4	Standby: 4	in-well	12 / 67
Middle Road	P & T (AS)	VOC	6	3	basin	156 /520
Western South Boundary	P & T (AS)	VOC	2	2	basin	10 / 32
Chemical Holes	P & T (IE)	Sr-90	1	2	dry well	0.388*** / 1.27***
North Street	P & T (carbon)	VOC	2	1	wells	115 / 115
North Street East	P & T (carbon)	VOC	2	1	wells	5 / 5
LIPA/Airport	P & T and recirc. (carbon)	VOC	9	1	wells and in-well	62 / 62
Industrial Park East	P & T (carbon)	VOC	2	1	wells	17 / 17
BGRR/WCF	P & T (IE)	Sr-90	5	NA	dry wells	NA
Operable Unit IV						
AS/SVE	AS/SVE	VOCs	-	-	-	35
Operable Unit VI						
EDB	P & T (carbon)	EDB	2	1	wells	<1**** / <1****

Notes:
AS = air stripping
AS/SVE = air sparging/soil vapor extraction
BGRR/WCF = Brookhaven Graphite Research Reactor/ Waste Concentration Facility
EDB = ethylene dibromide
HFBR = High Flux Beam Reactor
IE – ion exchange
LIPA = Long Island Power Authority
NA = not applicable
P & T = pump-and-treat
Sr-90 = strontium-90
* This system was shut down August 1, 2004 and placed in standby mode.
** This system was shut down June 1, 2005 and placed in standby mode.
*** Sr-90 removal is expressed in mCi.
**** EDB was not detected in the system influent in 2004. Other low-level VOCs, not attributable to BNL, were detected, but the results may be due to analytical lab contamination.

Operable Unit I

Soils: From 2000 through 2005, radioactively contaminated soils exceeding the selected cleanup levels have been excavated from the various OU I source areas such as landscape soils, Building 650 Sump and Sump Outfall, Upland Recharge/Meadow Marsh, the former HWMF, Building 811, and disposed of at an appropriately licensed facility. The BNL soil cleanup levels for principal radiological contaminants, based on the selected land use for each area, are provided in Table 6.

Table 6: BNL OU I Soil Cleanup Levels

Radionuclide	Soil Cleanup Level (pCi/g) Residential Land Use	Industrial Land Use
Cesium-137	23	67
Strontium-90	15	15
Radium-226	5	5

Note: A post cleanup dose assessment is required to determine compliance with the 15 mrem/year total dose limit.

The Building 650 Sump and Sump Outfall soil excavation met the cleanup level of 23 pCi/g for Cs-137 that allows for residential land use following 50 years of institutional control. Building 811 excavation is also expected to meet the 23 pCi/g level. The former HWMF (except for the future excavation at the Waste Loading Area) met the cleanup level of 67 pCi/g that allows for industrial land use following 50 years of institutional control, and residential land use following 100 years of institutional controls. Confirmatory documentation data that the Building 650 remediation met the cleanup level is provided in the closeout report. The *Final Closeout Report for the Meadow Marsh Operable Unit I Area of Concern 8* (BNL 2004b) and the *Final Closeout Report for the Ash Pit Operable Unit I Area of Concern 2F* (BNL 2004c) document the completion of response actions for these areas.

The Merrimack holes at the former HWMF are a series of horizontal circular waste storage holes inside a concrete shielding wall in the northeast portion of the yard (not in the Waste Loading Area). The holes are empty of waste, and one is undergoing final cleanout of minor surface contamination. According to the former HWMF Design Implementation Plan, the hole did not have contamination levels exceeding the cleanup goals, and therefore did not need to be removed. The clean out of the minor surface contamination is being performed as a closeout item from the BNL Exit Readiness Review that was conducted to transfer ownership of the facility from the BNL ER Projects Directorate to the Environmental and Waste Management Services Division. The decontamination of that Merrimack hole is expected to be completed in July 2006.

Disposal Pits: The Chemical/Animal/Glass Holes were successfully excavated in 1997, disposed of at an appropriately licensed facility, and a closeout report that included confirmatory sampling data was issued at that time. Some of the contaminated soil was stockpiled and maintained in the area for several years prior to off-site disposal. Following final disposal of the soil stockpiles, residual mercury-contaminated surface soil remained at the Chemical Holes area. This remaining soil was excavated and properly disposed of off-site at an appropriately licensed facility in summer 2005. Confirmatory soil sampling was performed and the results were documented in an addendum to

the existing Chemical Holes Closeout Report in mid 2005 (BNL 2005i). The addendum documents that all waste excavated from the pits were disposed of and the area restored.

Landfills: The landfill areas were capped between 1995 and 1997. Monitoring data presented in the *Current Landfill Area Five-Year Evaluation Final Report* (BNL 2001c) and the *Former Landfill Area Five-Year Evaluation Report* (BNL 2002) indicate that, in general, contaminant concentrations have decreased following the capping of the landfills. Since then, groundwater monitoring data presented in the annual landfill reports continue to support this conclusion, and landfill controls continue to be effective. As part of the compliance monitoring for the Current Landfill, annual surface water and sediment sampling of the adjacent Wooded Wetland has been performed since 1999. Data from 1999 through 2004 indicate that risk to the adult eastern tiger salamanders from inorganic contaminants that may be in the sediment at this area is unlikely in four out of five years. 2001 monitoring data indicated a potential risk. Surface water results for inorganics generally indicate that there is a potential risk to larval salamanders from iron and aluminum concentrations.

Groundwater: Over the past 5 years, the OU I pump and treat system continued to maintain hydraulic control of contaminants originating from the Current Landfill and former HWMF, and prevented further contaminant migration across a portion of the site's southern boundary. As expected, the VOC mass removal has been steadily declining over the last several years, as indicated by low influent VOC concentrations. However, monitoring well data suggest that higher concentrations of VOCs are moving toward the capture zone of the system.

Operable Unit II

The remedial actions for the OU II AOCs are documented in the OU I and OU III RODs.

As a result of the silica grout injection process that took place at the BLIP facility during a Removal Action in 2000, data suggest that tritium in the soil pore water near the target vessel was displaced by the grout. Tritium concentrations in the groundwater downgradient of this facility subsequently increased to a high of 61,000 pCi/L in 2001. As required in the *BLIP Closeout Report Removal Action AOC 16K* (BNL 2001d), groundwater monitoring at this facility has continued. Over the past several years, the concentrations of tritium in the groundwater have been generally declining but have periodically increased due to natural increases in water table elevation that occurred between November 2002 and July 2003. Furthermore, the amount of tritium remaining in the vadose zone close to the water table is expected to decline over time due to the flushing mechanism from the rise and fall of the water table and by natural radioactive decay. As an added measure of protection, the Medical Department and Collider–Accelerator Department constructed a new protective cap over the Linac to BLIP spur in late 2004. The final remedy for the BLIP will be documented in a subsequent ROD.

Operable Unit III

Soil: Contaminated soil excavated during previous removal actions, such as the cesspools, Building 830 USTs, Building 479 PCBs, and Building 464 mercury has met cleanup goals. This was confirmed via endpoint samples, and the results were documented in the closeout or completion reports. Continued monitoring of the soil is not necessary. Excavation and off-site disposal of PCB-contaminated soil at the Building 96 former Scrapyard began in 2000 and

concluded in early 2005. Overall, approximately 2,200 cubic yards of soil were excavated at the Building 96 area. A summary of the excavations and the results of the confirmatory sampling results is provided in the *OU III Building 96 PCB Soil (AOC 26B) Excavation Closeout Report* (BNL 2005e). The PCB cleanup goals (from the NYSDEC TAGMs), as called for in the OU III ROD, were 1 part per million (ppm) for surface without cover material, and 10 ppm for surface or subsurface soils backfilled with at least 1 foot of clean cover material. Continued monitoring of the soil is not necessary, although surveillance (i.e., visual inspection) of the backfilled areas will continue.

Groundwater: Fourteen of the 16 planned groundwater treatment systems are included under OU III. The other two systems were installed under OU I and OU VI. Three of the OU III systems are in standby mode (HFBR Tritium Pump and Recharge, the Carbon Tetrachloride Pump and Treat, and the Building 96 Pump and Treat System, which was shutdown on June 1, 2005), since they met the criteria for shutdown. They will continue to be maintained and monitored, and will be restarted if necessary.

A review and evaluation of the performance data for the treatment systems is conducted monthly for most of the systems and quarterly for all the systems, as well as annually for all systems. A review and evaluation of all the groundwater plumes' monitoring data collected for the year, as well as data trends for prior years, is also performed annually. As noted above, trends for key groundwater monitoring wells are provided in the *2004 BNL Groundwater Status Report* (BNL 2005d) (Attachment 2 or http://webeims.b459.bnl.gov/gw_home/gw_home.asp).

Over the past 5 years, significant progress has been made in preventing and minimizing the migration of VOCs, tritium, and Sr-90 contamination in the groundwater. The configuration and operation of the groundwater remediation systems on and off of BNL property are successfully reducing the sources of contamination as well as cleaning up the downgradient portion of the plumes. A comparison of the extent and magnitude of the OU III VOC plume over time is presented in Figure 4. Projections of the remediation timeframe for the plumes is performed periodically. The cleanup objective of meeting MCLs in the Upper Glacial aquifer within 30 years is currently on track.

In 2004, significant progress was made toward remediation of the Magothy aquifer VOC contamination. In addition to the three Magothy aquifer remediation wells previously installed, two additional extraction wells were installed off site to actively remediate high concentrations of VOCs. Per the OU III ESD, the cleanup goal for the Magothy aquifer is to meet MCLs within 65 years. Through 2004, significant VOC mass removal has been evidenced at the Stratler Drive extraction well.

Additional OU III highlights based on groundwater data collected include the following.

- Because VOC concentrations in three of the four Building 96 recirculation wells remained low in 2004 (below 30 µg/L total volatile organic compounds [TVOCs]), they were shut down and placed in standby mode in mid 2004. (Note: TVOC is a summation of individual VOC concentrations. Since most of the groundwater plumes consist of several individual VOCs, for purposes of reporting, groundwater modeling, and treatment system operations management, TVOCs are used. However, when an evaluation of whether the cleanup goals

for the groundwater have been met, the focus is on meeting the standards for the individual VOC). In addition, two applications of the oxidizer potassium permanganate were applied in December 2004/January 2005 and April 2005 to degrade the persistent high PCE groundwater contamination in the shallow silt zone source area. Good progress in PCE remediation has been observed, and additional potassium permanganate applications will continue as needed until the cleanup goals, as identified in the *OU III Building 96 Groundwater Treatment System Shutdown Petition (AOC 26B)* (BNL 2005f), are met.

- During 2004, the maximum tritium concentration in wells on the HFBR lawn was 378,000 pCi/L. This indicates that tritium continues to be flushed out of the unsaturated zone by natural water table fluctuations. The highest tritium concentration observed in the downgradient portion of the plume was 55,000 pCi/L. The plume continues to attenuate as expected, and no contingency limits were exceeded that would require pumping to resume. A comparison of the extent and magnitude of the HFBR Tritium plume over time is presented in Figure 5.
- During pre-design groundwater data collection in 2003 for the BGRR/WCF plumes, Sr-90 was detected at concentrations higher than previously identified. This, in combination with lessons learned during the operation of the Chemical Holes Pilot Study, resulted in the need for a change to the Sr-90 remedy in the OU III ROD. The ESD, approved in 2005, still calls for active treatment of the Sr-90 contaminated groundwater, but the time to meet MCLs was extended to within 70 years for the BGRR/WCF plumes and 40 years for the Chemical Holes plume.
- Two Middle Road wells and one South Boundary extraction well, EW-4/EW-5 and EW-12, respectively, were placed on standby in October 2003 due to continued low VOC concentrations.
- There have been no exceedances of any system equivalency permit liquid or air discharge levels except for occasional low pH levels in the effluent that is naturally occurring in this area.

Operable Unit IV

Soil: Remediated radiological contaminated soil at the Building 650 Sump Outfall is included under OU I.

Groundwater: The treatment system was dismantled in 2003, and groundwater monitoring continues to show a decline in VOC concentrations, with concentrations barely above the drinking water standards.

Operable Unit V

Soil/Sediment: In 2002 and 2003, soil exceeding the mercury and Cs-137 selected cleanup levels defined in the ROD was excavated from the sludge drying beds, sand filter berms, firing range berms, and sewer lines. The cleanup levels are less than 2 ppm for mercury and an average of 23 pCi/g for Cs-137, with no areas greater than 69 pCi/g. The 2 ppm value is based on both ecological and human health considerations. Based on confirmatory sampling, all areas met the prescribed cleanup levels, thereby minimizing the potential for migration of contaminants from the surface soil to groundwater. The results are documented in the *Final Completion Report Remedial Action*

AOC 4 STP, Sludge Drying Beds and Sand Filter Beds/Berms, AOC 21 Abandoned Former Sewer Lines (BNL 2004d).

Excavation of the metal and PCB-contaminated sediment in the Peconic River on and off of BNL property was initiated in May 2004 and completed in April 2005. The goal was that all mercury concentrations in the remediated areas would be less than 2 ppm following the cleanup (the 2 ppm is a value negotiated among the regulators for this site and is based on both ecological and human health considerations). Based on confirmatory sampling, these cleanup levels were met. The closeout report for Phases 1 and 2 was issued to the regulatory agencies. A monitoring program is being implemented to demonstrate the effectiveness of the cleanup. This includes near-term monitoring to establish the basis for a long-term monitoring program. The OU I Soils and OU V Long-Term Monitoring and Maintenance Plan was submitted to the regulators for review in mid 2005, and issued as final in May 2006 (BNL 2006).

Groundwater: Active treatment of the contaminated groundwater was not required by the ROD. However, the groundwater continues to be monitored. Since 1999, TVOC concentrations continue to remain low, typically less than 35 µg/L. Tritium has consistently remained well below the drinking water standard of 20,000 pCi/L. See Attachment 1 for historical VOC and tritium trends.

Prompted by the detection of perchlorate in a SCDHS monitoring well located east of BNL, the Laboratory sampled select OU V and STP monitoring wells for this compound during 2004. Perchlorate was detected in four of the OU V wells, but levels were below the New York State Department of Health Action Level of 18 µg/L in drinking water supply wells. BNL has added routine perchlorate analyses for eight OU V wells in 2005. SCDHS performed additional monitoring for perchlorate off of the BNL site. Information on perchlorate is available at http://www.epa.gov/fedfac/pdf/perchlorate_guidance.pdf and http://www.epa.gov/fedfac/documents/perchlorate_qa.htm.

Operable Unit VI

Groundwater: Monitoring groundwater over the past five years has shown generally consistent EDB concentrations. The plume is now located completely beyond the BNL boundary with the highest EDB concentration of 7.6 µg/L, exceeding the 0.05 µg/L drinking water standard. A groundwater treatment system was installed and began operation in late 2004. Although no EDB was detected in the influent in 2004, some low-level VOCs were detected but are not attributable to BNL.

BGRR

Structures and Soil: Completion and closeout reports document the final status of the various removal action cleanup activities since 1999 at the BGRR. The pile fan sump, piping, and associated soils were successfully removed, and the associated soils remediated to the following: Dose rate of less than 15 mRem/yr, Cs-137 less than 23 pCi/g, and Sr-90 less than 15 pCi/g. When multiple radionuclides were detected, the sum of the fractions was used to insure the maximum total dose limit of 15 mrem/yr is not exceeded. Soil samples were collected in the areas adjacent to the above ground ducts, and verified residential release criteria were met. The removal of the spent fuel canal was completed in April 2005, and a closeout report was issued

Groundwater: Monitoring of the BGRR Sr-90 groundwater plume over the past five years has consistently shown Sr-90 concentrations significantly above the 8 pCi/L drinking water standard. Supplemental characterization efforts in the fall of 2003 to support the design of a groundwater treatment system identified Sr-90 up to 3,150 pCi/L. The previous high concentration of Sr-90 was 566 pCi/L. To address the high concentrations of Sr-90, a groundwater treatment system was installed in late 2004. The system began operations in June 2005.

Groundwater Monitoring

The *2004 BNL Groundwater Status Report* (BNL 2005d) identifies changes to the well monitoring network at BNL (see Section 5.0 of http://webeims.b459.bnl.gov/gw_home/gw_home.asp). The changes include the installation of additional temporary and permanent monitoring wells, and modifications to monitoring frequency and analytical parameters.

6.5 Inspections

Representative site inspections took place between March 10, 2005 and May 24, 2005 for the landfills, soils, BGRR, Peconic River, and groundwater. Representatives from BNL and DOE attended, and the regulatory agencies were offered the opportunity to participate. Inspections for the Building 96 PCB Soil Cleanup and the Chemical Holes were performed in October and November 2005. The purpose of the inspections was to assess the protectiveness of the various sites, including operating treatment systems and controls. No significant issues were identified during the site inspections, but some follow-up recommendations were identified. The completed inspection checklists are included in Attachment 3. Five of the 16 groundwater treatment systems were not formally inspected at this time; however, all of the systems are routinely inspected as part of the ongoing O&M. In addition, Tier 1 assessments, that evaluate primarily safety and operational concerns, are performed on all of the systems at least annually. The more significant recommendations are included in Section 9, Table 7.

6.6 Interviews

Interviews consisted of discussions with the EPA, DEC, SCDHS, and DOE representatives. Questions from the list below were asked during the interview; however, each representative was not asked all of the questions on the list. Potential interview questions included:

- What is your overall impression of the cleanup at BNL?
- Are there any specific aspects of the cleanup that you feel should be of particular focus during the review?
- Do you feel well informed about BNL's cleanup activities and progress?
- Do you believe the public is sufficiently informed of the cleanup progress?
- Do you believe the remedies are functioning as expected by the RODs?
- Are you aware of any particular component of the cleanup decisions that pose a higher degree of difficulty in achieving?
- Are you aware of any recent or upcoming changes to federal or New York State laws, regulations, or cleanup standards that may impact protectiveness of human health and the environment at BNL?

- Do you believe there are current opportunities to optimize operations and maintenance, or sampling efforts at BNL that could result in cost savings or improved efficiency?
- What do you think are the biggest risks to achieving the soil and groundwater cleanup objectives at BNL?
- Do you feel confident that BNL and DOE will continue to actively manage the long-term cleanup operations for the site, including maintaining appropriate institutional controls?
- Do you have any comments, suggestions, or recommendations regarding BNL/DOE management of the cleanup?

The following individuals were specifically contacted for interviews concerning the BNL site:

- Mr. Douglas Pocze – EPA Region 2
- Ms. Mary Logan – EPA Region 5 (formerly of EPA Region 2)
- Mr. James Lister, NYSDEC
- Mr. Andy Rapiejko, SCDHS
- Mr. Martin Trent, SCDHS
- Ms. Gail Penny, DOE

Most people interviewed thought the cleanup is going well and that communication with the regulators and the community is good. Concerns identified with groundwater cleanup were: ensuring that the cleanup goals are met as projected by the model; evaluate actual progress made compared to model projections; and make changes to the systems as necessary to meet the goals. The former EPA Project Manager has confidence that DOE will continue to manage and fund the long-term cleanup. However, the current EPA Project Manager is not confident that the cleanup will continue to be managed properly, and feels that this is an agency-wide concern for federal facilities. The NYSDEC representative had similar concerns but remained hopeful. Suffolk County is concerned about the loss of institutional knowledge during the transfer from the Environmental Management Directorate (ERD) to the Long-Term Response Actions Group at BNL. DOE and the county requested that the Five-Year Review include focus on institutional controls and residual contamination. The interview summaries are included under Attachment 4.

7.0 Technical Assessment

7.1 Operable Unit I

OU I Question A: Is the remedy functioning as intended by the decision documents?

OU I Remedial Action Performance

- Based on a review of the closeout reports completed for the soil/disposal pit cleanups and wetland restoration, site inspections, and regulatory interviews, the remedies were implemented in accordance with the OU I ROD and the soil cleanup levels were met. This has achieved the objectives of preventing human exposure including direct external exposure, ingestion, inhalation, and dermal contact, as well as environmental exposure to contaminants. Reconstruction of the Upland Recharge/Meadow Marsh area wetlands was successfully implemented, and has minimized uptake of contaminants in the soil/sediment by ecological receptors, including the eastern tiger salamander. Aquatic vegetation plants have been established at an 85 percent or better success rate at this area. Native grasses adjacent to the pond were replanted in the spring of 2004 using a seed drill, and rip-rap was installed in 2004 on the pond slopes to prevent erosion. Reconstruction of the former HWMF wetlands was performed in mid 2005. For the soil excavation remedies completed, such as the former HWMF, Building 811, and the former residual surface soils at the Chemical Holes, the work was performed in accordance with the ROD, applicable design documents, and Remedial Action Work Plans. The soil cleanup levels defined in the ROD have been met for these areas. Construction activities also adhere to project-specific BNL Work Permits to ensure the work is carried out safely and that controls are in place.
- The landfill areas were capped in accordance with the ROD and the NYS Part 360 requirements. The buried waste is contained, and the caps have achieved the objective to minimize the further leaching of contaminants from the soil into the groundwater. The soil cover placed on the ash pit prevents direct contact with the metals in surface soils and migration from wind blown dust.
- The OU I groundwater pump and treat system has been functioning since 1997 as intended by the ROD. The system is on track to reach the overall groundwater goals of meeting MCLs within 30 years in the Upper Glacial aquifer. However, the 2002 and 2003 *BNL Groundwater Status Reports* raised concerns over the rate of cleanup of the aquifer relative to the cleanup goals. These reports concluded that some portions of the targeted cleanup area did not appear to be progressing as quickly as simulated in the groundwater modeling performed during the design of the system. As a result, two temporary wells were drilled in 2004 to assess the model predictions.

The refined groundwater model suggested that by 2011, active pump and treat activity at OU I will have reduced the peak TVOC concentrations to approximately 90 µg/L, and limited these contaminant zones to a very small area of the Upper Glacial aquifer within the BNL property limits. This remaining contamination is predicted to naturally attenuate to levels below MCLs by 2025, which is within the cleanup goal time period in the ROD. The model also reasonably matches concentrations at six select monitoring wells over an 8-year period. Figure 6 shows good overall correlation between the 2004 actual plume data compared to the modeled predictions.

OU I System Operations/O&M

- O&M of the landfill caps are performed as required by the O&M manuals. O&M of the cap and drainage structures have been effective. A few small areas of the Current Landfill showed evidence of burrowing by small animals. The burrows did not penetrate beyond the soil layer, therefore, are they do not affect the protectiveness of the cap. The burrows were filled in and repaired. Also, one of the gates at the landfill needed to be repaired so it can be properly locked. Monthly inspections will continue to ensure that the cap is effectively maintained and repaired as necessary.
- The OU I Soils and OU V Long-Term Monitoring and Maintenance Plan, that consolidates the monitoring and maintenance requirements identified in separate documents, was submitted to the regulators in July 2005 and issued as final by BNL in May 2006 (BNL 2006).
- Sampling of the Wooded Wetland surface water and sediment since the 1999 OU I Ecological Risk Assessment has provided consistent data to help evaluate any potential impacts to the tiger salamander and its habitat. Continued routine monitoring of this area is included in the *BNL Environmental Monitoring Plan.* Because the data has shown consistently low sediment and surface water metal concentrations when compared to maximum benchmark sediment concentrations, critical concentration values for surface water, and BNL background concentrations for sediment and surface water, the need to continue the annual sampling beyond 2005 should be evaluated. Monitoring of the tiger salamander's use of the wetland will continue as identified in the BNL Natural Resource Management Plan (as well as the OU I Soils and OU V Long-Term Monitoring and Maintenance Plan).
- The OU I treatment system operated without any significant down time or maintenance issues over the past eight years, and the system effluent has consistently met the discharge requirements. The O&M manual identifies required preventative maintenance tasks, and there do not appear to be any issues that would impact continued operations or the effectiveness of the remedy. The O&M manual is currently being updated to reflect detailed exit strategy criteria for system shutdown.

OU I Costs of System Operations/O&M

- Over the past four years, the average annual O&M cost for the OU I treatment system was approximately $160K. The estimated annual cost from the 1996 Action Memorandum was approximately $190K.

OU I Implementation of Institutional Controls and Other Measures

- *The Land Use Controls Management Plan* (LUCMP, BNL 2005g) provides an overview of land use and other controls that are deployed at BNL to prevent exposure to residual environmental contamination, and to ensure the long-term effectiveness of the remedies. This plan is a living document and is periodically updated and reviewed by the regulators to stay current with evolving management techniques.
- Several existing BNL procedures have been modified to ensure that proposed land and facility use activities are consistent with defined land use and institutional controls. They require a review for the new or changed use of a BNL facility or land parcel and for conducting work on BNL property. The procedures, along with a web-based land

use/institutional control (LU/IC) database that includes geographic data on the cleanup areas, and fact sheets, ensure that facilities or parcels of land on the BNL site evaluated for future use are the most appropriate and that any potential conflicts with land use and institutional controls are identified and resolved prior to any subsequent facility and/or land use decisions. The LU/IC website is currently being updated to enhance the site-specific institutional controls for each area. The database will be available for regulator review at http://luic.bnl.gov/website/landcontrols/. An uncontrolled copy of the area of concern factsheets, that identify specific institutional controls, are included in Attachment 6.

- The land use and institutional controls that are in place and maintained for OU I include:
  - Postings to communicate potential hazards and aid in controlling access at areas such as Building 650 Sump Outfall, Upland Recharge/Meadow Marsh pond, and former HWMF. Following a facility walk-through by BSA and DOE, the prior outdated postings at the FHWMF were removed and replaced with point of contact signage prior to entry. A separate radiological posting was added to the Waste Loading Area portion of the FHWMF. The need for point of contact signs at some of the other post soil cleanup areas is currently being evaluated.
  - Prohibitions on excavation activities in designated residual contaminated soil areas, and disturbance and erosion of the landfill and ash pit caps. The cap and the surrounding area were undisturbed.
  - Fencing around cleanup areas such as the Current Landfill, former HWMF, and Building 811 WCF to aid in controlling physical access. As noted in the System Operations/O&M section above, even though the gate to one the Landfills was broke, there did not appear to be any disturbance noted during the monthly inspections.
  - Maintenance of landfill engineered caps to prevent continued groundwater contamination and covers over residual soil contamination to aid in preventing the direct exposure of such contamination to site workers, visitors, and wildlife.
  - Several wetland areas that may contain protected habitats are adjacent to the former HWMF. NYSDEC regulations regulate all work within 100 feet of wetlands with confirmed protected species habitats. Any work activities within 100 feet of a wetland requires DOE and NYSDEC notification and approval.
  - BNL limits activities within 850 feet of wetlands with confirmed protected species habitats.
  - Restrictions/controls on the pumping and recharge of groundwater on the BNL site until cleanup levels are achieved. This will help maintain consistent groundwater flow directions.
  - Groundwater monitoring to track contaminant plumes as well as reporting in the Annual Groundwater Status Report.

  No activities were observed at OU I that would have violated these institutional controls.

OU I Monitoring Activities

- The monitoring data obtained from the treatment system as well as the data from the plume monitoring wells provide the basis to evaluate system performance and effectiveness. The monitoring wells are categorized as background, core, perimeter, or bypass wells. Identification of the wells sampled and their monitoring frequency is updated annually and

presented in the *BNL Environmental Monitoring Plan*. The monitoring data are reported in the *BNL Groundwater Status Report*.

- Confirmatory monitoring data are collected following the completion of soil excavation projects. These data are used to confirm that the designated cleanup levels have been met and the excavation can be backfilled. In addition, for radiological soil cleanups, ORISE has performed independent sampling of the excavated areas to confirm that defined cleanup levels have been achieved.

OU I Opportunities for Optimization

- Five years' worth of sediment and surface water data have been collected and evaluated from the Wooded Wetland area. The results have consistently shown null to minor impact to the eastern tiger salamander habitat from potential leachate from the Current Landfill. It is recommended that an evaluation be conducted to reduce the sampling frequency following the 2005 sample period.
- All existing plume core wells for the OU I groundwater treatment system show TVOC concentrations less than 50 µg/L (the capture goal of the system). Furthermore, the system influent concentrations have been less than 12 µg/L for 2004. Consequently, it is recommended to implement reductions in system operations, and to pulse the treatment system wells to optimize system performance.

OU I Early Indicators of Potential Issues

There do not appear to be any problems or issues at this time that could place protectiveness of the remedies at risk.

OU I Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?

OU I Changes in Standards and To Be Considereds (TBCs)

- The standards or TBCs in the OU I ROD have not changed nor do they call into question the protectiveness of the remedy. Except for arsenic (discussed below), radiological soil cleanup levels and the MCLs for drinking water are unchanged since 1999. Attachment 7 provides the cleanup levels for the OU I primary contaminants of concern.
- Note that the drinking water standard for arsenic changed in 2001 from 50 µg/L to 10 µg/L. Arsenic was detected above the standard in three of the ten downgradient Current Landfill monitoring wells. However, the remedy for OU I is not affected since the arsenic levels are low. The highest historical arsenic level in these wells was 35 µg/L in May 2004. The next highest level in another well was 14 µg/L. Monitoring for arsenic will continue.

OU I Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics, and Risk Assessment Methods

- There have been no changes in the physical conditions within OU I or in the use of the site that would reduce the protectiveness of the remedies or require updates to the risk assessment. The exposure assumptions used in the original risk assessment are consistent with current land use.

- No new contaminants or sources of contamination have been identified within OU I, and no unanticipated toxic byproducts have been detected.
- A preliminary initial screening of the OU I groundwater VOC plume was performed to evaluate the potential for soil vapor intrusion. Groundwater contamination immediately beneath the Current Landfill is shallow and exceeds MCLs for several VOCs. However, inhabited buildings are not located near this plume. The closest office building to this plume is approximately 1,000 feet upgradient of the contaminant plume. Therefore, the subsurface vapor to indoor air pathway is incomplete, and no further evaluation is needed. The downgradient portion of the plume is deeper and has a clean layer of groundwater above. Therefore the contaminants are not present in the uppermost portion of the groundwater (i.e., water table) to present a soil gas concern. Attachment 8 presents the soil vapor intrusion screening for the plume.
  In the event that further construction is planned at BNL within the area of the OU I VOC groundwater plume, BSA will re-evaluate any potential issues and, if necessary, undertake appropriate measures to address them. Any construction projects to be undertaken at the Lab are reviewed for environmental, security, safety and health concerns in the conceptual design or early planning phase. BSA procedure, EP-ES&H-500, Project Environmental, Security, Safety and Health Review, includes an ES&H 500A Evaluation Form that requires any potential issues, such as potential soil vapor gas intrusion, be identified, documented, and mitigative actions taken, if necessary. In addition, the LUCMP and the Groundwater plumes factsheet will be revised to reflect the potential for soil vapor intrusion should new buildings be proposed.

OU I Expected Progress in Meeting RAOs

- Projects completed to date within OU I continue to meet the remedial action objectives identified in the OU I ROD, based on post-excavation confirmatory soil sampling results, continued monitoring of the surface waters and sediment, groundwater monitoring downgradient of potential source areas, and visual inspections of remediated areas.
- The future soil excavation at the former HWMF Waste Loading Area is expected to adhere to the ROD cleanup levels and meet the overall ROD objectives.
- The OU I groundwater treatment system is on schedule for meeting the ROD cleanup goal of reaching MCLs in the Upper Glacial aquifer is within 30 years (by 2025 for the OU I plume). As mentioned previously, the system is on track for planned shutdown by 2011, followed by continued monitoring. The system has already removed more mass of VOCs from the aquifer than previously projected.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

- There is no additional information that calls into question the protectiveness of the remedies at OU I.
- Although BNL now maintains a more comprehensive list of protected species (i.e., species of concern) for the site, they are not at risk from contamination.

7.2 Operable Unit II

The AOCs in this OU are documented in the OU I and OU III RODs, except for BLIP, which will be documented in a subsequent ROD. The following questions relate to remedial actions taken at the BLIP facility:

OU II Question A: Is the remedy functioning as intended by the decision documents?

- Silica grout was injected into the activated soil at the BLIP facility in 2000. This Removal Action was an additional protective measure to further reduce the permeability of the activated soil. Moreover, it would reduce the potential impact of rainwater leaching radionuclides into the groundwater, should the primary storm water controls fail. The Removal Action also included stormwater drainage improvements and maintenance, installation and maintenance of the gunite cap, and continued groundwater monitoring.
- As reported in the *BLIP Closeout Report Removal Action AOC 16K* (BNL 2001d), the injection of the silica grout at BLIP can be characterized as successful; however, its deployment was not. The objectives of minimizing threats to human health, migration of contaminants to the groundwater, and migration from operations of the facility in the future appear to have been met. However, the displacement of contaminated soil pore water during the injection caused a short-term impact to the groundwater. As a result, the goal of improving the control of the activation area "without harm to the environment" was not achieved. As discussed in Section 6.4 above, the concentrations of tritium in the groundwater have been generally declining over the past several years and are expected to dissipate.
- The stormwater diversions and cap inspection and repair are included under BNL's Preventative Maintenance Program. The gunite cap, paved areas, and roof drains at BLIP are in good condition and are effectively controlling stormwater infiltration. Although direct inspection or maintenance of the silica grout is not possible, it is expected to be in good condition and would be effective in preventing significant leaching of tritium from the activation zone.
- Quarterly groundwater monitoring in the immediate vicinity of BLIP continues per the *BNL Environmental Monitoring Plan*, and the results are reported to the facility operator on a routine basis and in the annual *Groundwater Status Report*.
- The final remedy for the BLIP project will be documented in a subsequent ROD, scheduled for submittal to the regulators in September of 2006.

OU II Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?

- The Removal Action objective to prevent further migration of radionuclides from the activated soil to the groundwater is still valid. There have been no changes to the exposure assumptions or the drinking water standards.
- There have been no physical changes to the BLIP area except as an added measure of protection, a new protective concrete cap over the Linac-to-BLIP spur was constructed in late 2004. The spur is where the beam line from Linac is kicked into the Linac to BLIP beam line. As part of an effort to investigate potential upgradient sources of tritium, soil samples obtained in 2003 along the BLIP spur identified low levels of sodium-22

activation. In accordance with BNLs Accelerator Safety Subject Area, if potential leachate concentrations can exceed five percent of the drinking water standard, the beam loss area must be capped. As a result, the concrete cap was installed in November 2004.

OU II Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

There is no additional information that calls into the question the protectiveness of the remedy at BLIP.

7.3 Operable Unit III

OU III Question A: Is the remedy functioning as intended by the decision documents?

OU III Remedial Action Performance

- The OU III groundwater plumes have been defined, and continue to be monitored via a comprehensive network of monitoring wells on and off of the BNL property. Plume maps are updated on at least an annual basis.
- Remediation of the OU III plumes has been underway since 1997. Eleven systems are in operation and are capturing the plumes as intended by the OU III ROD, thereby preventing and minimizing migration of contaminants. The last treatment system was installed in late 2004, and is used to address the Sr-90 plumes at the BGRR/WCF. Operations for this system began in June 2005.
- The groundwater remediation program is on track to reach the overall groundwater cleanup objectives as defined by the OU III ROD as modified by the OU III ESD. These objectives are:
    - Meet MCLs for VOCs and tritium in the Upper Glacial aquifer within 30 years
    - Meet MCLs for Sr-90 at the former Chemical Holes plume and the BGRR/WCF plumes within 40 years and 70 years, respectively
    - Meet MCLs for VOCs in the Magothy aquifer within 65 years

- Three groundwater systems met their cleanup goals and were placed in standby mode. These are the HFBR Tritium Pump and Recharge System (2000), the Carbon Tetrachloride Treatment System (2004), and the Building 96 Treatment System (2004/2005). Should contamination significantly rebound, the systems can be restarted.
- Operations data obtained during the 2003 Chemical Holes Sr-90 treatment system Pilot Study and subsequent 2004 operations helped to define the final remedy for the BGRR/WCF Sr-90 treatment system.
- Cleanup of the Magothy aquifer was significantly enhanced in 2004 with the installation of two additional extraction wells off of the BNL property (at the LIPA/Airport and Industrial Park East treatment systems) to address the high concentrations of VOCs.
- A detailed discussion of the progress of the OU III groundwater remediation is available in the *2004 Groundwater Status Report* (BNL 2005d) (see Attachment 2 for the CD or http://webeims.b459.bnl.gov/gw_home/gw_home.asp).
- Ten homeowners within the designated public water hookup area declined the free DOE hookup offer in 1996-1997 and continued to use their private wells for drinking purposes. That number was reduced to seven homeowners in 2005 and six in early 2006. In mid

2006, two additional homes were identified that were previously thought to be connected to public water. This brings the number of homes not connected to public water to eight. DOE continues to offer these homeowners free annual water testing. The response rate to the annual letters sent to the homeowners over the several years has been low, between one to two taking DOE up on the offer each year. The well results have been below the New York State Department of Health drinking water standards, except for iron in one case. Iron is not normally considered harmful to health, but can cause off-taste, odor or staining problems. In this case, the County recommended connection to a public water supply wherever possible.

- Excavation and off-site disposal of PCB-contaminated soil at Building 96 was performed in accordance with the ROD. The designated soil cleanup levels were met. Also, as required by the ROD, the final remedy for the potential source such as the Building 96 anomalies was documented in a subsequent decision document, the *OU III Explanation of Significant Differences* (BNL 2005a). The remedy called for no further action.

OU III System Operations/O&M

- The VOC treatment systems operated without any significant downtime or other operational issues over the past eight years, and treatment system discharges have consistently met the state equivalency discharge requirements (although there have been a few minor pH excursions due to the natural groundwater conditions). The systems are physically inspected, typically on a daily basis. However, the frequency of physical inspections will generally be reduced starting in 2005 due to the positive operating history, the increase in the number of systems off of BNL property, and the availability of wireless system monitoring/alarms.
- As noted in Section 4.3 above, the process piping is being redesigned to bypass the holding tanks and use only the extraction well pump to process the water, to reduce the frequency of system downtime for the Chemical Holes Sr-90 system.
- The systems' O&M manuals identify required preventative maintenance tasks. There do not appear to be any issues that would impact continued operations or the effectiveness of the remedy. The BNL Preventive Maintenance Program helps to eliminate unnecessary system shutdowns due to routine wear and tear on equipment. The O&M manuals for the Industrial Park System and the Chemical Holes Sr-90 system are currently being updated to reflect more recent exit strategy criteria for system shutdown.
- An evaluation of the operations of each of the treatment systems is performed on a varying time scale: monthly during preparation of the discharge monitoring reports, during preparation of the quarterly operation reports, and annually in the Groundwater Status Report. These evaluations include review of the extraction well and system influent data, treatment system midpoint data, if appropriate, and the effluent data.
- Maintenance of the system recharge basins, such as periodic scraping to remove sediment buildup, is performed in accordance with the *Natural Resource Management Plan for Brookhaven National Laboratory* (BNL 2003b) to ensure protection of potential eastern tiger salamander habitats.

OU III Costs of System Operations/O&M

- The O&M costs over the past four years for several of the OU III treatment systems are

presented in Table 3 in Section 4.3. The annual costs are equivalent to, if not lower than, the original estimates. BNL has been able to operate these systems in a cost-efficient manner by optimizing the sampling programs and implementing lessons learned. The largest overall cost drivers for the systems are electricity and disposal or reuse of spent carbon and resins.

- BNL has successfully minimized costs for several systems by shutting off extraction wells when influent concentration data and groundwater contamination levels at a given location are very low. The extraction wells remain in standby mode and continue to be monitored. If necessary, the wells could be restarted.
- Due to the extensive use of activated carbon for the treatment of VOCs off of the BNL property, a large-scale waste services contract was awarded based on competitive bidding.
- Since the signing of the OU III ROD in 2000, two access agreements were negotiated with private property owners to allow treatment system operations on their property. In consideration for the agreements, payments of $84K per year will be made to the property owners for as long as the treatment systems are on their property.

OU III Implementation of Institutional Controls and Other Measures

- Institutional controls are in place at BNL to ensure the effectiveness of all groundwater remedies. The OU III groundwater land use and institutional controls continue to be maintained and effective in protecting human health and the environment. These controls include:
    - Groundwater quality is monitored in the vicinity of each treatment system to evaluate the system's performance and to detect any change in conditions that might result in the system not meeting its stated objective or threatening a water supply source. The details of this monitoring are prescribed in the *BNL Environmental Monitoring Plan.*
    - Extensive groundwater monitoring program to track contaminant plumes and reporting of the data.
    - Monitoring of BNL potable supply system and SCDHS monitoring of Suffolk County Water Authority (SCWA) well fields closest to BNL.
    - Remediation progress is reviewed annually as part of the Groundwater Status Report.
    - Five-Year reviews are performed, as required by CERCLA, until cleanup goals are met and to help determine the effectiveness of the groundwater monitoring program.
    - Controls are placed on the installation of new supply wells and recharge basins on BNL property.
    - Public water service has been offered in plume areas south of BNL.
    - Installation of new drinking water wells and other pumping wells where public water service exists is prohibited (Suffolk County Sanitary Code Article 4).
    - BNL maintains an internal Water and Sanitary Planning Committee to coordinate operational activities on the BNL site that may impact the flow of contaminated groundwater. The committee also tracks and evaluates changes in groundwater management activities off of the BNL site (i.e. SCWA and drainage changes planned in the vicinity of BNL) to determine if they will affect BNL groundwater remedies. There was a lapse for several months in 2005 where the pumping of supply wells was not optimal, thereby resulting in a shifting of plumes slightly to the

east. This situation is currently being corrected via formalization within the Labs policy and procedures. The Committee now meets on a monthly basis to discuss various issues.
    - Property access agreements for treatment systems off of BNL property are in place, and have not been violated. Deed restriction transfer with property ownership change will be completed in mid 2005.
    - The deeds for certain private properties beyond the BNL boundary are being updated to reflect the operation of the North Street, North Street East, and OU VI remediation systems.
    - The treatment systems installed off of the BNL site are fenced, with locked gates, locked buildings, and video surveillance with direct feed back to BNL police. No security violations have been identified by the police.

  As a result of routine and non-routine inspections and close oversight of the facilities, no activities were observed at OU III that would have violated these institutional controls.

- The Building 96 PCB-excavated soil area will be inspected every 6 months to verify that the cover material is staying in place and is not impacted by erosion, animal burrowing, or root intrusion. After seeding in 2005, the area was added to the BNL web-based database of contaminated soils map so that any proposed disturbance of the backfilled areas (i.e., digging, well installation, building construction) is controlled to prevent contact with the remaining low-level PCB-contaminated soil.

OU III Monitoring Activities

- Monitoring data obtained from the treatment systems, as well as the data from groundwater monitoring wells, provide the basis to evaluate the performance and effectiveness of the various systems. The data is reported in the Annual Groundwater Status Report.
- Changes to several of the OU III plume monitoring networks are being recommended in the *2004 Groundwater Status Report* (BNL 2005d). These modifications, which include the installation of additional permanent monitoring wells and temporary wells, will increase BNL's confidence in tracking the contaminant plumes and assessing remediation progress. The changes to the Middle Road, South Boundary, Chemical Holes, Former Landfill, and Industrial Park East plume monitoring programs are described in more detail in the *2004 BNL Groundwater Status Report*.

OU III Opportunities for Optimization

- As part of the *2004 BNL Groundwater Status Report*, optimization of several of the OU III groundwater treatment systems was recommended. These changes are based on an evaluation of treatment system and monitoring well VOC concentration trends. The proposed changes include:
    - In October 2005, begin pulse-pumping the two extraction wells at the Western South Boundary System due to the steadily decreasing influent concentrations of VOCs, and because six out of seven plume core wells have reached the cleanup objective of 20 μg/L TVOCs.

- Continue to maintain the Carbon Tetrachloride treatment system in standby mode, and restart extraction well(s) if necessary.
- In October 2005, shut down and place in standby mode Industrial Park system treatment well UVB-1 because VOC concentrations were below MCLs throughout 2004.
- In October 2005, begin pulse pumping of the five Airport treatment system extraction wells because no monitoring wells or extraction wells have VOC concentrations above MCLs.

OU III Early Indicators of Potential Issues

- There do not appear to be any problems or issues at this time that could place protectiveness of the remedies at risk.
- The remedy for the Building 96 groundwater treatment system, consisting of recirculation wells with air stripping treatment, assumed that there was no continuing source of VOC contamination. However, following system operations for two of the three proposed years of treatment and the installation of additional temporary monitoring wells, it was determined that a zone of high VOC contamination existed in a low permeability (silty) zone located in the subsurface within the source area. It was determined that continued pumping of the extraction well would not be effective at eliminating this source. As a result, the remediation approach was reevaluated in 2004. In December 2004/January 2005 and again in April 2005, the oxidizer, potassium permanganate, was injected into the silt zone to degrade the VOCs. Success was realized, however, spot injections of the oxidizer may continue as needed to reduce the high VOCs until they are reduced to lower concentrations. This approach is expected to maintain protectiveness and attain MCLs in the groundwater within 30 years.

OU III Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?

OU III Changes in Standards and TBCs

- The standards or TBCs identified in the OU III ROD have not changed nor do they call into question the protectiveness of the remedy. Attachment 7 provides the cleanup levels for the OU III primary contaminants of concern. The PCB soil cleanup levels and MCLs for drinking water have remained the same since 1999.
- In 2000, a New York State guidance value for methyl-tertiary-butyl-ether (MTBE) was established at 10 µg/L. Then in December 2003, the New York State Department of Health (NYSDOH) adopted a 10 µg/L MCL for MTBE. Between September 2002 and April 2003, BNL detected MTBE in a monitoring well that serves as an outpost (or early warning) well for the SCWA William Floyd Well Field just west of the site. One of the detections exceeded the standard. However, SCDHS sampled the well in January and April 2003 and did not detect any VOCs, including MTBE. MTBE was not detected for the remainder of 2003 and all of 2004. The regulators were informed of the detections. The only known MTBE contamination at BNL is associated with the BNL Motor Pool Area and Service Station, but these areas are not believed to be the source of the MTBE detected in the outpost well. MTBE is not a contaminant of concern and does not affect the OU III remedy.

OU III Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics, and Risk Assessment Methods

- There have been no changes in the physical conditions within OU III or in the use of the site that would reduce the protectiveness of the remedies or render the initial risk analysis invalid. Also, the exposure assumptions have not changed since the ROD was signed in 2000.
- Ten homeowners within the designated public water hookup area declined the free DOE hookup offer in 1996–1997, and continued to use their private wells for drinking purposes. That number was reduced to seven homeowners in 2005, and six in early 2006. However, in mid 2006, two additional homes were identified, and brought the total that continue to use their well as their sole source of drinking water to eight. DOE continues to offer these eight homeowners free annual water testing.
- No new contaminants or sources of contamination have been identified within OU III, and no unanticipated toxic byproducts have been detected. BNL continues to analyze for vinyl chloride at the Building 96 potassium permanganate injection area to ensure it is not being created from the degradation of PCE.
- A preliminary initial screening of the OU III groundwater VOC plume was performed to evaluate the potential for soil vapor intrusion. Those OU III plumes located near and beyond the property boundary, or a distance from former source areas have a clean layer of groundwater above and are deeper. Therefore the contaminants are not present in the uppermost portion of the groundwater (i.e., water table) to present a soil gas concern. There are a couple of areas on BNL property where OU III VOC groundwater contamination is shallow and closer to former source areas, such as Building 96 and the Carbon Tetrachloride plumes. However, inhabited buildings are not located near the plumes. The closest building is the service station. Consequently, the subsurface vapor to indoor air pathway is incomplete, and no further evaluation is needed at this time. Attachment 8 presents the soil vapor intrusion screening for the OU III plumes.

  In the event that further construction is planned at BNL within the area of the OU III VOC groundwater plumes, BSA will re-evaluate any potential issues and, if necessary, undertake appropriate measures to address them. Any construction projects to be undertaken at the Lab are reviewed for environmental, security, safety and health concerns in the conceptual design or early planning phase. BSA procedure, EP-ES&H-500, Project Environmental, Security, Safety and Health Review, includes an ES&H 500A Evaluation Form that requires any potential issues, such as potential soil vapor gas intrusion, be identified, documented, and mitigative actions taken, if necessary. In addition, the LUCMP and the Groundwater plumes factsheet will be revised to reflect the potential for soil vapor intrusion should new buildings be proposed.

OU III Expected Progress in Meeting RAOs

- There are currently 12 groundwater remediation systems in operation under OU III, of which five began operation in 2004. As noted in Section 7.3, all the systems are on track for meeting the ROD and ESD cleanup goal of reaching MCLs in the aquifer and

preventing or minimizing plume growth. The *2004 BNL Groundwater Status Report* (BNL 2005d) evaluates each system's performance based on five major decisions identified from the BNL groundwater Data Quality Objective (DQO) process (see *BNL Environmental Monitoring Plan* [BNL 2003c] for discussions of the DQO process).

- As noted above, in the Early Indicators of Potential Issues section, there was a concern with whether the Building 96 groundwater treatment system would meet its cleanup objective in light of the continuing "silt zone" source area. However, with the revised remedial approach of using potassium permanganate injections, BNL is confident that the objectives will be met.
- There are no known issues with any of the property access agreements for the treatment systems off of BNL property, or institutional controls, which could jeopardize their future operation.
- BNL will carefully evaluate the performance and efficiency of the Sr-90 ion exchange treatment systems at the Chemical Holes and the BGRR/WCF plumes to ensure that they are on track to meet their objectives of meeting MCLs within 40 years and 70 years, respectively. Increasing Sr-90 concentration trends in several key sentinel monitoring wells will be evaluated, and if necessary, changes will be made. Changes could include installing additional monitoring wells and/or additional extraction wells. BNL will also remain alert to any new Sr-90 remediation techniques and technologies, as well as any operational efficiencies that might accomplish cleanup sooner with less waste generation.
- Based on post-excavation PCB confirmatory soil sampling results and visual inspections at Building 96 Scrapyard, this project has met the cleanup goals identified in the OU III ROD.

OU III Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No new technologies have been identified at this time for the treatment of Sr-90 contaminated groundwater. No newly identified ecological risks have been found within OU III, nor impacts from natural disasters. No additional information has come to light that calls into the question the protectiveness of the OU III remedies.

7.4 Operable Unit IV

OU IV Question A: Is the remedy functioning as intended by the decision documents?

Although the OU IV ROD states that a Five-Year Review of this remedial action is not necessary, the following items are provided as a summary.

- The OU IV remedial action objectives have been satisfied. The soil/groundwater treatment AS/SVE system met its cleanup objectives and the regulators approved its dismantlement in 2003. A fence was installed around Building 650 Sump Outfall in 1995. The excavation of the radiological contaminated soil in the Building 650 Sump, along with the discharge pipe and Sump Outfall, was included under the OU I ROD.
- The remediation has achieved the objectives of preventing or minimizing the leaching of contaminants from the soil into the groundwater, human exposure (including ingestion, inhalation, and dermal contact), and the uptake of contaminants present in the soil and groundwater by plants and animals.

- Groundwater monitoring for select wells downgradient of the former AS/SVE system continues, as well as monitoring for radionuclides at the Building 650 Sump and Sump Outfall per the *BNL Environmental Monitoring Plan.* The results are reported in the annual Groundwater Status Report.
- The AS/SVE-remediated area is classified for unrestricted industrial use.
- The lead-contaminated soil at the Central Steam Facility outfall is not identified in the OU IV ROD since it is not an AOC. However, it was identified as a recommendation/ follow-up action during the OU IV Five-Year Review in 2003. Since that time, the characterization of the soil was completed and a report summarizing the results and an evaluation of remediation options was submitted to the regulators for review in March 2004. The report is titled, *Remedial Investigation and Soil Remediation Evaluation and Cost Estimate for the Central Steam Facility Storm Water Outfall*, dated February 2004.

OU IV Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?

- The standards or TBCs identified in the OU IV ROD have not changed, nor do they call into question the protectiveness of the remedy. The radiological soil cleanup levels and the MCLs for drinking water have remained the same since 1999. Attachment 7 provides the cleanup levels for the OU IV primary contaminants of concern.
- The remedial action objectives have been met and have not changed.
- The groundwater within OU IV is not contaminated with VOCs above MCLs, therefore, the subsurface vapor to indoor air pathway is incomplete, and no further evaluation is needed.

OU IV Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No additional information calls into the question the protectiveness of the remedy at OU IV.

7.5 Operable Unit V

OU V Question A: Is the remedy functioning as intended by the decision documents?

OU V Remedial Action Performance

- Based on information presented in the closeout report for the sludge drying beds, sand filter beds and berms, firing range berms, and sewer line cleanups (BNL 2004d), and on regulatory interviews, the remedies were implemented in accordance with the OU V STP ROD. Based on confirmatory sampling, all areas met the prescribed cleanup levels for Cs-137 and mercury, thereby minimizing the potential for migration of these contaminants from the surface soil to groundwater.
- Removal of elevated levels of Cs-137 and mercury minimizes the potential for uptake of these contaminants in the soil by ecological receptors. Backfilling with clean material further reduces the potential for exposure.
- Groundwater contaminated with low levels of VOCs and tritium continues to be monitored on a routine basis. The extent of the VOC plume is well defined and is updated annually. All tritium concentrations remain less than the 20,000 pCi/L drinking water standard.

- Excavation of the sediment in the portion of the Peconic River on BNL property was completed in accordance with the requirements of the Action Memorandum *Peconic River Removal Action for Sediment on BNL Property* (BNL 2004e), as well as the OU V Peconic River ROD. Based on confirmatory sampling discussed in the *Completion Report for Peconic River Remediation On BNL Property* (Envirocon 2004), the cleanup goal for mercury has been met. This remedy is considered the final remedy in the OU V Peconic River ROD.
- Excavation of the sediment in the portion of the Peconic River off of BNL property was completed in accordance with the requirements of the OU V Peconic River ROD. Based on confirmatory sampling, the cleanup goal for mercury has been met. The *Draft Closeout Report for Peconic River Remediation Phases 1 and 2* (BNL 2005c) was issued to the regulators.
- Average silver, copper, PCB, and Cs-137 concentrations in sediment on and off of BNL property were reduced to background concentrations as a result of the cleanup.
- Ecological risks are expected to be reduced to background. Monitoring of the ecological receptors will be performed in accordance with the OU V Peconic River ROD and further detailed in the *Operable Unit I Soils and Operable Unit V Long-Term Monitoring and Maintenance Plan* (BNL, 2006).

OU V System Operations/O&M

- As required by the OU V Peconic River ROD, a long-term monitoring program will be implemented to ensure protection of human health and the environment. As noted above, a long-term monitoring and maintenance plan was prepared that included methyl mercury water column sampling, sediment sampling, and fish sampling on and off of BNL property.
- Pilot studies performed for the Peconic River restoration have demonstrated that wetland restoration techniques have been effective. However, additional monitoring of the progress of the vegetation regrowth in the Peconic River is required.

OU V Costs of System Operations/O&M (Not applicable for this project.)

OU V Implementation of Institutional Controls and Other Measures

- The OU V groundwater land use and institutional controls continue to be maintained and effective in protecting human health and the environment. These controls include:
    - The New York State general advisory on the consumption of freshwater fish caught from New York freshwaters applies to the Peconic River. The advisory is to eat no more than one meal (1/2 pound) of fish per week.
    - The DOE does not envision any sale or transfer of property in the Peconic River area. If it were to occur, the sale or transfer would meet the requirements of Section 120 (h) of CERCLA to ensure that future users are not exposed to unacceptable levels of contamination.
    - Excavation activities in designated residual contaminated soil areas are prohibited.
    - Groundwater monitoring to track contaminant plumes as well as reporting in the Annual Groundwater Status Report.
    - Five-year reviews will be performed, as required by CERCLA, until cleanup goals are met, to determine the effectiveness of the groundwater monitoring program and

sediment remediation.
    - Controls have been placed on the installation of new supply wells and recharge basins on BNL property.
    - NYSDEC regulations regulate all work within 100 feet of wetlands with confirmed protected species habitats. Any work activities within 100 feet of a wetland requires DOE and NYSDEC notification and approval.
    - BNL limits activities within 850 feet of wetlands with confirmed protected species habitats.
    - Installation of new drinking water wells and other pumping wells where public water service exists is prohibited (Suffolk County Sanitary Code Article 4).

As a result of inspections performed at the STP and the Peconic River, no activities were observed at OU V that violated these institutional controls.

OU V Monitoring Activities

- Confirmatory monitoring data was collected following the completion of the soil excavation at the STP sludge drying beds and sand filter beds/berms. These data confirmed that the cleanup levels were met, and permitted the excavation to be backfilled. In addition, ORISE performed independent sampling of the excavated areas to confirm the cleanup for DOE. This is documented in the *Final Completion Report for the STP* (BNL 2004d).
- Confirmatory monitoring data was collected following the completion of the Peconic River sediment excavation on and off of BNL property. These data confirmed that the cleanup levels were met. The *Completion Report for the Peconic River Remediation on BNL Property* (Envirocon, 2004) documents that the mercury cleanup levels were met. The confirmatory data for the sediment off of BNL property is documented in a closeout report that was submitted to the regulators.
- As noted above, monitoring of surface water, sediment, fish, and vegetation regrowth will be performed. In addition to periodic reporting of the analytical results, the data will be evaluated during subsequent five-year reviews, and an assessment will be made on the effectiveness of the remedy in meeting the cleanup and restoration objectives. The need for potential additional remedial actions will also be evaluated.
- The groundwater monitoring over the past five years shows no indication of VOC or tritium concentrations increasing in magnitude.
- Groundwater monitoring will continue and the data is reported in the Annual Groundwater Status Report.

OU V Opportunities for Optimization

At this time, there are no opportunities for optimization of the monitoring activities at the STP, the Peconic River, or the groundwater.

OU V Early Indicators of Potential Issues

- The regrowth of invasive species (e.g., *phragmites*), is a significant concern for the long-term success of the Peconic River revegetation. Monitoring, followed by appropriate controls for the invasive species *phragmites*, is needed on a timely basis.
- As required by the NYSDEC Equivalency Permit, the stone and fabric from the haul access roads need to be removed. However, once they are removed and the path is revegetated,

access to the river for future sediment and water sampling may become difficult. Access options need be evaluated.

- Although there is currently no drinking water standard for the compound perchlorate, NYSDOH has established an Action Level in drinking water supply wells of 18 µg/L. Several monitoring wells at the STP have detected perchlorate, but at concentrations below the action level. The impacts from the future establishment of a lower drinking water standard will be evaluated at that time. Perchlorate is not a contaminant of concern in the ROD, and does not affect the remedy for OU V. Additional information on perchlorate is available at http://www.epa.gov/fedfac/pdf/perchlorate_guidance.pdf and http://www.epa.gov/fedfac/documents/perchlorate_qa.htm.

OU V Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?

OU V Changes in Standards and TBCs

- The standards or TBCs identified in the OU V ROD have not changed nor do they call into question the protectiveness of the remedy. The mercury sediment cleanup level and the MCLs for drinking water have remained the same since 1999. Attachment 7 provides the cleanup levels for the OU V primary contaminants of concern.

OU V Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics, and Risk Assessment Methods

- There have been no changes in the physical conditions within OU V or in the use of the STP, the Peconic River, or the groundwater that would reduce the protectiveness of the remedies or render the initial risk analysis invalid. The exposure assumptions used in the original risk assessment are consistent with current land use.
- DOE continues to offer free annual water testing to the one homeowner known to be using a private well for drinking water purposes in the OU V public water hookup area. The last time the homeowner accepted the annual test was in February 2002. These results were below the State Department of Health drinking water standards, except for iron. Iron is not normally considered harmful to health, but can cause off-taste, odor or staining problems. At the time, the County recommended connection to a public water supply wherever possible.
- No new contaminants or sources of contamination have been identified within OU V, and no unanticipated toxic byproducts have been detected.
- A preliminary initial screening of the OU V groundwater VOC plume was performed to evaluate the potential for soil vapor intrusion. The plume is deeper and has a clean layer of groundwater above. Therefore the contaminants are not present in the uppermost portion of the groundwater (i.e., water table) to present a soil gas concern.

OU V Expected Progress in Meeting RAOs

- Excavation of the radiological and metal contaminated sediments at the STP and in the Peconic River on and off of BNL property met the appropriate cleanup levels and remedial action objectives in the OU V STP and OU V Peconic River RODs. A monitoring program is being implemented to demonstrate the effectiveness of the Peconic River cleanup to

mitigate potential ecological effects.
- Groundwater monitoring results continue to indicate that MCLs will be met within 30 years.

OU V Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No newly identified ecological risks have been found within OU V or impacts from natural disasters. No additional information has come to light that calls into question the protectiveness of the OU V remedies.

7.6 Operable Unit VI

OU VI Question A: Is the remedy functioning as intended by the decision documents?

OU VI Remedial Action Performance

- The OU VI EDB groundwater plume has been defined and continues to be monitored via a network of monitoring wells on and off of BNL property. The plume map is updated on at least an annual basis.
- The EDB groundwater treatment system was installed in accordance with the OU VI ROD, and began operating in August 2004. Although EDB has yet to be detected in the extraction wells, the hydraulic capture performance of the system is being met as described in the Startup Report. The recent detection of EDB at levels just above detection limits in a plume core well located immediately north of the extraction wells indicates that the leading edge of the plume is just now arriving at this location. The system is currently on schedule to meet the cleanup goals of reaching MCLs within 30 years.
- DOE continues to offer free annual water testing to the three remaining known homeowners still using private wells for drinking water purposes in the OU VI public water hookup area. A fourth homeowner connected-up to public water in the fall of 2005. The one homeowner that recently hooked-up previously accepted the annual testing offer in 2003, 2004, and 2005. The other three homeowners had their wells last sampled in 2002 or 2003. The results for all samples were below the State Department of Health drinking water standards.

OU VI System Operations/O&M

- The system O&M manual identifies required preventative maintenance tasks. There do not appear to be any issues that would impact continued operations or the effectiveness of the remedy. The BNL Preventive Maintenance Program helps to eliminate unnecessary system shutdowns due to routine wear and tear on equipment.
- An evaluation of the operation of the treatment system is performed monthly during preparation of the discharge monitoring reports, during preparation of the quarterly operation reports, and annually in the *BNL Groundwater Status Report*. These evaluations include review of the extraction well and system influent data, treatment system midpoint data, and the effluent data. From March 28 through May 24, 2005, VOC analyses were inadvertently not performed. The matter was corrected, and on May 25, 2005 all parameters were being analyzed.

OU VI Costs of System Operations/O&M

- The system is still in the first year of O&M. The largest overall cost drivers for the system are annual property access payments and electricity.
- Since the OU VI ROD was signed in 2001, two access agreements were negotiated with private property owners to allow for treatment system operations on their property. In consideration for the agreements, payments of $85K per year will be made to the property owners as long as the treatment system is on their property. These costs are in addition to the payments required for the OU III systems discussed above.

OU VI Implementation of Institutional Controls and Other Measures

- The OU VI groundwater land uses and institutional controls continue to be maintained and effective in protecting human health and the environment. These controls include:
    - Groundwater quality is monitored in the vicinity of the EDB treatment system to evaluate its performance and to detect any change in conditions that might result in the system not meeting its stated objective or threatening a water supply source. The details of this monitoring are prescribed in the *BNL Environmental Monitoring Plan* (BNL 2003c*).*
    - Groundwater monitoring to track the contaminant plume as well as reporting in the Annual Groundwater Status Report.
    - Monitoring by SCDHS of Suffolk County Water Authority well field at Country Club Drive in Manorville.
    - Five-year reviews will be performed, as required by CERCLA, until cleanup goals are met.
    - Public water service is in place in the OU VI plume area south of BNL.
    - Installation of new drinking water wells and other pumping wells where public water service exists is prohibited (Suffolk County Sanitary Code Article 4).
    - BNL maintains an internal Water and Sanitary Planning Committee to coordinate operational activities on the BNL site that may impact the flow of contaminated groundwater. The Committee also tracks and evaluates changes in groundwater management activities off of the BNL site (i.e., SCWA and drainage changes planned in the vicinity of BNL) to determine if they will affect BNL groundwater remedies.
    - Property access agreements are in place for the OU VI treatment system off of BNL property. Deed restriction transfer with property ownership change will be completed in mid 2005.
    - The deeds for certain private properties beyond the BNL boundary are being updated to reflect the operation of the OU VI remediation system.
    - The EDB treatment system off of the BNL site is fenced, has locked gates, a locked building, and video surveillance provides direct feed back to BNL police. No violations have been identified.

  Based on inspections, no activities were observed at OU VI that would have violated these institutional controls.

OU VI Monitoring Activities

- The monitoring data obtained from the EDB treatment system, as well as the data from the plume monitoring wells, provide the basis to evaluate the performance and effectiveness of the remediation system. The data is reported in the Annual Groundwater Status Report.
- Changes to the OU VI plume monitoring network would be recommended in the annual *Groundwater Status Report*. These modifications, such as additional monitoring wells and temporary wells, would increase BNL's confidence in the plume's distribution and remediation progress.

OU VI Opportunities for Optimization

There are no opportunities identified at this time because the system has been operating for less than one year.

OU VI Early Indicators of Potential Issues

There do not appear to be any problems or issues at this time that could place protectiveness of the remedy at risk.

OU VI Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?

OU VI Changes in Standards and TBCs

- The regulatory standards or TBCs identified in the OU VI ROD have not changed nor do they call into question the protectiveness of the remedy. The EDB standard and the MCLs for drinking water have remained the same since 1999. Attachment 7 provides the cleanup levels for the OU VI primary contaminants of concern.
- Note that the SPDES equivalency discharge permit level for EDB was assigned as 5.0 µg/L by NYSDEC. The drinking water standard for EDB is 0.05 µg/L. BNL is striving to reduce the EDB concentrations in the treated effluent to below the drinking water standard. This is not considered a change in standards or TBCs.

OU VI Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics, and Risk Assessment Methods

- There have been no changes in the physical conditions within OU VI or in the use of the site that would reduce the protectiveness of the remedies or render the initial risk analysis invalid. Also, the exposure assumptions have not changed since the ROD was signed in 2001.
- DOE continues to offer free annual water testing to the three homeowners in the OU VI plume area who are still using their private wells for drinking purposes. A fourth homeowner previously hooked-up to public water in the fall of 2005. The one homeowner that previously hooked-up accepted the water testing offer in 2003, 2004, and 2005. The other three homeowners had their wells last sampled in 2002 or 2003. The results for all samples were below the State Department of Health drinking water standards.

- A preliminary initial screening of the OU VI groundwater VOC plume was performed to evaluate the potential for soil vapor intrusion. The portion of the plume that exceeds the MCL is located off of the BNL property boundary, is deeper, and has a clean layer of groundwater above. Therefore the contaminants are not present in the uppermost portion of the groundwater to present a soil gas concern.

OU VI Expected Progress in Meeting RAOs

- The annual *BNL Groundwater Status Report* evaluates the system's performance based on five major decisions identified from the BNL groundwater DQO process (see *BNL Environmental Monitoring Plan* (BNL 2003c) for the DQO process). As described in the *2004 BNL Groundwater Status Report* (BNL 2005d), EDB concentrations are expected to be lowered to below the 0.05 µg/L MCL by 2030, as required by the OU VI ROD.
- There are no known issues with the property access agreements or institutional controls that could jeopardize the EDB system's future operation.

OU VI Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No newly identified ecological risks have been found within OU VI or impacts from natural disasters. No additional information has come to light that calls into question the protectiveness of the OU VI remedy.

7.7 BGRR

BGRR Question A: Is the remedy functioning as intended by the decision documents?

BGRR Remedial Action Performance

- As described in the completion and closeout reports completed to date, site inspections, and regulatory interviews, the interim cleanup measures were implemented in accordance with the Action Memos and are consistent with the BGRR ROD. This has achieved the remedial action objectives of: protecting human health from the hazards posed by the radiological inventory at the BGRR, using the ALARA principle, and implementing monitoring, maintenance, and institutional controls to manage potential hazards. Specific activities completed include:
    - Removal of Primary Air Cooling Fans - Removed and properly disposed of contaminated equipment in the fan rooms and decontaminated or fixed surface contamination.
    - Removal of the Pile Fan Sump, Pipes, and Contaminated Soil – Removed to reduce the radiological footprint of the BGRR complex.
    - Removal of Above Ground Ducts, Pipes, and Contaminated Soil – Prevented low-level radioisotopes from being released to soil and potential migration into groundwater.
    - Removal of Canal and Water Treatment House, Piping, and Accessible Contaminated Soils – Reduced the amount of contamination in the concrete

structures of the canal and removed contaminated surface soil to reduce the radiological footprint of the BGRR complex.
    - Removal of the Exhaust Cooling Coils and Filters – To prevent the future migration of radiological contamination into surrounding soil and groundwater.
    - Removal of BGD Primary Liner – To prevent the future migration of radiological contamination into surrounding soil and groundwater.
    - Sealing of the BGDs – To prevent the future migration of radiological contamination into surrounding soil and groundwater.
    - Removal of the Canal Structure, and Subsurface Contaminated Soil – To prevent the future migration of radiological contamination into surrounding soil and groundwater.

- The April 2005 completion of the removal of the canal structure and subsurface contaminated soil located outside the footprint of the reactor building was performed in accordance with the Action Memorandum and is consistent with the selected remedy in the BGRR ROD. A completion report was prepared and issued to the regulators in mid 2005.
- A temporary asphalt cap will be installed over the soil areas in mid 2005 to minimize water infiltration prior to the final cap installation.
- The remaining work to be performed including removal of the graphite pile and biological shield, and installation of the final engineered cap for water infiltration management, is to be implemented in accordance with the ROD, work plans, design documents, and BNL work permit.
- The Sr-90 groundwater plume is defined, is located entirely on the BNL property, and continues to be monitored via a comprehensive network of monitoring wells. Plume maps are updated on at least an annual basis. Groundwater is being monitored and remediated under the OU III ROD and ESD.

BGRR System Operations/O&M

- As required by the 2005 BGRR ROD, long-term O&M activities will be conducted to ensure effectiveness of the remedy. The BNL LUCMP contains sitewide control measures and land-use restrictions to prevent exposure to environmental contamination and to protect the integrity of remedies specified within this and other approved RODs. To accomplish this objective, specific measures are being implemented for the BGRR project. They include the following:

    - Routine environmental health and safety monitoring
    - Periodic structural inspections of Building 701
    - Water intrusion monitoring
    - Preventive maintenance of Building 701 and the infiltration management system
    - Groundwater monitoring required as part of the OU III ROD and the ESD.

BGRR Costs of System Operations/O&M

The estimated cost of long-term actions is approximately $275K annually for routine surveillance and groundwater monitoring. Additionally requirements include $10K every 10 years for infiltration barrier upkeep and $700K every 20 years to refurbish the Building 701 exterior facade and roof system. The cost estimate assumes these long-term actions are performed following completion of the remaining ROD remediation activities at the pile and

bioshield. Repointing of the Building 701 brickwork is currently in progress.

BGRR Implementation of Land Use and Institutional Controls and Other Measures

In addition to the administrative controls placed on the future land use at BNL, the following specific institutional controls will be included as part of the remedial design for the BGRR complex and will be included in the BNL Land Use and Institutional Controls Database in 2005:

- Control measures for future excavation of residual subsurface contamination - No digging, drilling, ground-disturbing activities, or groundwater shall be extracted within the area designated in Figure 10-1 of the BGRR ROD unless the activity has undergone a BNL review process, which includes but is not limited to the restrictions in BNL's LUCMP. This figure is included as Figure 7. Any activity that occurs deeper than 15 feet will require EPA concurrence. Upon implementation of the BGRR remedy, a reassessment will be made to determine the area in which the digging, drilling, ground-disturbing and groundwater extraction restrictions will be applied during the post-remedy phase.
- Following any future excavation, modifications to the existing limitations on land use/reuse will be in accordance with NYSDEC regulations.
- Specific land use restrictions are established within the BNL LUCMP limiting future use and development of the BGRR complex to commercial or industrial uses only. Additionally, any future plans for excavation of the inaccessible contaminated soils will include the assessment of risk to human health and the environment based on the actual distribution, depth, and concentrations of the residual radioactive material encountered.
- Annual certification will be provided to NYSDEC verifying that the institutional controls and engineering controls put in place are unchanged from the previous certification, and that nothing has occurred that would impair the ability of the control to protect public health or the environment. The annual certification will be prepared and submitted by a professional engineer or environmental professional accepted by NYSDEC.
- Land use restrictions and reporting requirements will be passed on to any/all future landowners through an environmental easement on the deed to the property. In light of the fact that a deed does not exist for property owned by a federal entity, DOE will be responsible for implementing, enforcing, maintaining, and reporting on these controls. Although DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the DOE or its successor agency shall retain ultimate responsibility for remedy integrity. Upon transfer of the property to a nonfederal entity by the U.S. government, a deed will be established and an environmental easement will be added to the deed at that time.

BGRR Monitoring Activities

- Monitoring environmental health and safety, such as radiological dose monitoring, is a significant component of the remediation completed to date as well as for the remaining work. The ALARA principle is used to control worker exposure throughout all phases of the remediation effort.
- Groundwater monitoring in the vicinity of the BGRR complex will continue throughout the institutional control period. Results of the OU-III BGRR/WCF monitoring program will be

used to help verify the effectiveness of the BGRR remedy.

- Water intrusion monitoring is routinely performed in accordance with a surveillance and maintenance procedure to ensure that water does not infiltrate into contaminated areas of the BGRR complex, which could potentially cause the migration of radiological contamination into surrounding soils and groundwater.

BGRR Opportunities for Optimization

There are no apparent opportunities for optimization at this time.

BGRR Early Indicators of Potential Issues

Of particular concern is ensuring the protectiveness of workers during the remaining pile and bioshield removal. Proper planning, that includes continued focus on health and safety, use of the ALARA principle, daily tailgate meetings, and contingency measures, will help mitigate potential risk.

BGRR Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?

BGRR Changes in Standards and TBCs

The standards or TBCs, including DOE Orders, identified in the BGRR ROD have not changed nor do they call into question the protectiveness of the remedy. Attachment 7 provides the cleanup levels for the BGRR primary contaminants of concern.

BGRR Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics, and Risk Assessment Methods

- There have been no changes in the physical conditions within the BGRR complex or in the use of the site that would reduce the protectiveness of the remedies or render the initial risk analysis invalid. Also, the exposure assumptions have not changed since the ROD was signed in 2005.
- No new contaminants or sources of contamination have been identified within the BGRR, and no unanticipated toxic byproducts have been detected.

BGRR Expected Progress in Meeting RAOs

- A significant effort has already been completed with the removal and disposal of contaminated components, structures, water, and soil at the BGRR complex. Based on sampling results, continued monitoring and surveillance of the facility, groundwater monitoring downgradient of potential source areas, and visual inspections of remediated areas, those projects completed to date continue to meet the remedial action objectives identified in the ROD.
    - A portion of the radiological inventory at the BGRR has been either removed or stabilized as a result of the interim cleanup actions.
    - The ALARA principle was extensively used to help protect workers while implementing the removal actions.

- The implementation of long-term monitoring, maintenance, and institutional controls has been initiated for the BGRR.

- The remaining remedial activities to be implemented for the pile and bioshield removal, as well as installation of the temporary and final engineered caps, are also expected to meet the overall ROD remedial action objectives.

  - Once completed, the overall remedy will remove over 99 percent of the radioactive material inventory at the BGRR complex.
  - The Building 701 foundation will protect the contaminated soil and components that will remain under the building footprint. It will form a significant barrier to future excavation and direct exposure, and serve as an effective barrier to prevent the migration of the remaining contaminants to groundwater.
  - Water infiltration management and institutional controls will be effective in protecting human health and the environment.

- As noted in Section 7.3 above, BNL will carefully evaluate the performance and efficiency of the Sr-90 ion exchange treatment system implemented/used for remediation of the BGRR/WCF plumes to ensure that they are on track to meet their objectives as stated in the OU III ROD and ESD of meeting MCLs in the aquifer within 70 years. BNL will also remain alert to any new Sr-90 remediation techniques and technologies as well as any operational efficiencies that might accomplish cleanup sooner with less remediation waste.

BGRR Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No newly identified risks have been found within the BGRR complex, nor impacts from natural disasters or land use changes. No additional information has come to light that calls into question the protectiveness of the BGRR remedy.

7.8 Technical Assessment Summary

Currently, seven of eight RODs have been signed at BNL. The ROD for the remaining OU, the g-2 Tritium Plume, BLIP, and USTs (AOCs 16T, 16K and 12), is still pending and is due for submittal to the regulators in the fall of 2006. This additional time allows for the collection of additional groundwater monitoring data for the g-2 tritium plume to support the evaluation of alternatives in the Focused Feasibility Study (FFS). With the exception of remaining soil excavation/waste disposal at the OU I former HWMF Waste Loading Area and the BGRR pile and bioshield removal, all selected remedies for the seven RODs have been implemented. This includes the excavation and off-site disposal of contaminated soil, sediment, tanks, and the installation and operation of all planned groundwater treatment systems. All closeout reports were prepared and submitted to the regulators. As noted earlier, another decision document will be prepared for the HFBR.

Remedies have been implemented in accordance with the RODs and the ESD, according to the data presented in the closeout reports and the annual *BNL Groundwater Status Reports*, site inspections, and regulatory interviews. Soil cleanup levels were met and groundwater pump and treat systems have been functioning as intended by the RODs. The cleanup performed continues to meet the remedial action objectives identified in each ROD.

For soil excavation/disposal remedies, work was performed in accordance with the ROD, applicable design documents, and Remedial Action Work Plans. Soil cleanup levels were met for these areas. The remaining work at the former HWMF Waste Loading Area and BGRR will be implemented in accordance with the ROD.

There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedies. Soil and groundwater applicable or relevant and appropriate requirements in the RODs and ESD have either been met or are expected to be met. Although there were minor changes to two drinking water standards, arsenic and MTBE, they are not related to contaminants of concern and do not affect the remedies. There is no other information that calls into question the protectiveness of the remedies.

8.0 Issues

Issues are identified in Section 9, Table 7.

9.0 Recommendations and Follow-up Actions

Table 7: Recommendations and Follow-up Actions

Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Document OU I and OU V monitoring and maintenance requirements in one document	Prepare and submit the OU I Soils and OU V Long-Term Monitoring and Maintenance Plan to the regulators	BNL	DOE, EPA, DEC, SCDHS	July 2005 (actual of 8/12/05)	N	N
Some USTs in AOC 12 are not documented as final remedies in a ROD	Document the final remedy for remaining AOC 12 USTs in the g-2/BLIP ROD	BNL	DOE, EPA, DEC, SCDHS	October 2006	N	N
OU I - Animal burrows in Current Landfill cap, and gates broken	Repair current burrows and fix gates	BNL	DOE, EPA, DEC, SCDHS	July 2005 (gates fixed 12/16/05, burrows repaired 2/27/06)	N	N
OU I - Consistent long-term results from Wooded Wetland Monitoring	Evaluate the need to continue the annual sampling or reduce the frequency	BNL	DOE, EPA, DEC, SCDHS	September 2005 (actual of 8/12/05)	N	N
Institutional controls documentation needs updating	Update Land Use Controls Management Plan and web-based database	BNL	DOE, EPA, DEC, SCDHS	September 2005 (Plan updated 6/17/05)	N	Y
OU I - Consistent low VOCs in OU I extraction wells	Implement pulse pumping of treatment system to optimize performance	BNL	DOE, EPA, DEC, SCDHS	October 2005 (actual of 9/6/05)	N	N
OUs III, VI - Deeds not reflecting operating treatment systems	Complete survey/mapping of treatment systems off of BNL property and record updated deeds with County	BNL	DOE, EPA, DEC, SCDHS	June 2005 (Survey/mapping completed 6/30/05)	N	Y
OU III - Consistent low VOCs in WSB extraction wells	Implement pulse pumping of treatment system to optimize performance	BNL	DOE, EPA, DEC, SCDHS	October 2005 (actual of 9/6/05)	N	N
OU III - Consistent low VOCs in IP recirculation well	Implement pulse pumping of UVB-1 to optimize performance	BNL	DOE, EPA, DEC, SCDHS	October 2005 (actual of 10/05)	N	N
OU III - Consistent low VOCs in Airport recirculation wells	Implement pulse pumping of treatment system to optimize performance	BNL	DOE, EPA, DEC, SCDHS	October 2005 (actual of 10/3/05)	N	N
Enhance monitoring well network	Implement changes to various well networks based on 2004 Groundwater Status Report	BNL	DOE, EPA, DEC, SCDHS	October 2005 (actual of 10/05)	N	N
OU V – Restore haul roads	Per the DEC equivalency permit, remove stone/fabric	BNL	DOE, EPA, DEC, SCDHS	September 2005 (actual of 9/30/05)	N	N
Housekeeping	Dispose of miscellaneous monitoring well materials at Meadow Marsh & 650 Outfall, remove Spray Aeration piping and RA V tanks	BNL	DOE, EPA, DEC, SCDHS	August 2005 (Spray Aeration piping removed 1/11/06)	N	N

10.0 Protectiveness Statements

Individual Protectiveness Statements
Protectiveness statement for the individual OUs and the BGRR are presented below:

Operable Unit I: The remedy is expected to be protective of human health and the environment upon completion, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

- The remedy is expected to be protective upon attainment of soil cleanup goals once excavation at the former HWMF Waste Loading Area is complete, and once groundwater cleanup goals are met, which is expected to require 30 years or less to achieve. The decontamination of the Merrimack hole at the former HWMF will be complete in July 2006. In the interim, exposure pathways that could result in unacceptable risks are being controlled. Institutional controls are preventing exposure to, or the ingestion of, contaminated groundwater and soil. Contamination within OU I has been addressed through excavation of contaminated soil including disposal pits, capping of landfills, the installation of fencing and signs, and the implementation of specific institutional controls for soil and groundwater.
- Long-term protectiveness of the remedy will be verified by monitoring the movement and remediation of the plume. Current monitoring data indicate that the remedies are effective and they are functioning as required to achieve the groundwater cleanup goals.

Operable Unit II: Remedial actions for the AOCs in this OU are documented in the OU I and OU III RODs, except for BLIP and the g-2 tritium plume, which will be documented in a subsequent ROD. Since there is no ROD or remedial action for this OU, a protectiveness statement cannot be prepared. A protectiveness statement for the g-2, BLIP, UST AOCs will be prepared during the second Five-Year Review, following the issuance of a ROD.

Operable Unit III: The remedy is expected to be protective of human health and the environment upon attainment of groundwater cleanup goals. In the interim, exposure pathways that could result in unacceptable risks are being controlled.

- All soil cleanup actions are complete and all groundwater treatment systems are operational or in standby mode. The attainment of groundwater cleanup goals is expected to require:
  - 30 years or less to achieve MCLs for VOCs and tritium in the Upper Glacial aquifer,
  - 40 years and 70 years or less to achieve MCLs for Sr-90 at the former Chemical Holes plume and the BGRR/WCF plumes, respectively, and
  - 65 years or less to achieve MCLs for VOCs in the Magothy aquifer.
- Exposure pathways that could result in unacceptable risks are being controlled. Site-specific institutional controls are preventing exposure to contaminated groundwater and soil.

Long-term protectiveness of the remedies will be verified by continuing to monitor the movement and remediation of the plumes. Current monitoring data indicate that the remedies are functioning as required to achieve the groundwater cleanup goals.

Operable Unit IV: The remedy is expected to be protective of human health and the environment upon attainment of groundwater cleanup goals. In the interim, exposure pathways that could result in unacceptable risks are being controlled.

- The groundwater cleanup goals have been met for the VOCs/SVOCs present at the 1977 spill site, and the treatment system has been dismantled. Institutional controls are preventing exposure to contaminated soil and groundwater. All threats at the site have been addressed through the installation of fencing and warning signs, and the implementation of institutional controls.
- Long-term protectiveness of the remedial action will be verified by obtaining additional groundwater samples to fully evaluate potential migration of the Sr-90 plume downgradient of the source area. Current data indicate that the Sr-90 plume remains in the OU IV area and that the remedy is functioning as required to achieve groundwater cleanup goals.

Operable Unit V: The remedy currently protects human health and the environment because the contaminated soil at the STP filter beds and contaminated sediment in the Peconic River have been excavated to meet the appropriate cleanup levels. Revegetation of remediated areas has been completed. However, for the remedy to be protective in the long-term, the monitoring program must demonstrate the effectiveness of the Peconic River cleanup to mitigate potential ecological effects.

- The soil cleanup goals for the STP filter beds/berms have been met.
- All potential threats have been addressed through excavation of contaminated sediment, and the implementation of specific institutional controls for fish, soil/sediment, and groundwater.
- Long-term protectiveness of the remedy will be verified by continuing to monitor the sediment, surface water, fish, and revegetation. A long-term monitoring plan has been prepared. Similar to the other OUs, in addition to periodic reporting of the analytical results, the monitoring data will be evaluated during subsequent five-year reviews to evaluate the effectiveness of the remedy in meeting the cleanup and restoration objectives. The potential need for additional actions will also be evaluated.

Operable Unit VI: The remedy is expected to be protective of human health and the environment upon attainment of the groundwater cleanup goals. In the interim, exposure pathways that could result in unacceptable risks are being controlled.

- The EDB groundwater treatment system is operational. The attainment of groundwater cleanup goals is expected to require 30 years or less to achieve MCLs for EDB in the Upper Glacial aquifer.
- Exposure pathways that could result in unacceptable risks (e.g., off-site potable water supply) are being controlled and site-specific institutional controls are preventing exposure to, or the ingestion of, contaminated groundwater.

BGRR: The completed remedy is expected to be protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

- The remedy is expected to be protective upon completion of the pile and bioshield removal and installation of the final engineered cap. In the interim, exposure pathways that could result in unacceptable risks are being controlled. Institutional controls are preventing exposure to contaminated structures, soil, and groundwater.
- All threats at the site are being addressed through removal or stabilization of the radiological inventory, excavation of contaminated soil, infiltration management, the installation of signs, and the implementation of specific institutional controls for the structure, soil and groundwater.
- Long-term protectiveness of the remedy will be verified by continuing to perform health and safety monitoring, periodic structural inspections of Building 701, water intrusion monitoring, preventive maintenance and the infiltration management system, and groundwater monitoring required as part of the OU III ROD and the ESD.

Comprehensive Protectiveness Statement
A comprehensive sitewide protectiveness determination covering all the OUs and BGRR must be reserved at this time because:

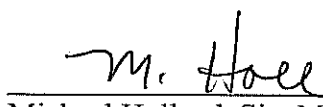
- Construction is not complete for OU I former HWMF Waste Loading Area soils, and the BGRR pile, bioshield, and final engineered cap.
- The final remedy for the g-2 Tritium Plume, BLIP, and USTs (AOCs 16T, 16K, and 12) has not yet been selected. The ROD is due for submittal to the regulators in the fall of 2006.

11.0 Next Review

The second sitewide Five-Year Review for BNL will be submitted within five years of issuance of this final Report. This will include all OUs, including the g-2 Tritium Plume, the BLIP, and USTs ROD (AOCs 16T, 16K, and 12). A comprehensive sitewide protectiveness determination will be included at that time.

Rodrigo V. Rimando, Brookhaven Project Director
Office of Environmental Management
U.S. Department of Energy

July 13, 2006
Date



Michael Holland, Site Manager
Brookhaven Site Office
U.S. Department of Energy

7/13/06
Date

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