BROOKHAVEN
NATIONAL LABORATORY

Five-Year Review Report

for

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

March 31, 2011

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

PREPARED BY:
Environmental Protection Division
Brookhaven National Laboratory
Upton, New York 11973

NSF
Registered to ISO 14001

Executive Summary

The U.S. Department of Energy (DOE) owns the Brookhaven National Laboratory (BNL) site in Upton, New York, 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 include excavation and off-site disposal of contaminated soil, sediment, tanks, and structures, capping of landfills, installation and operation of groundwater treatment systems, groundwater monitoring, and implementation of institutional controls. All of the remedies for the nine signed Records of Decision (RODs) and two Explanation of Significant Differences (ESDs) have been fully implemented except for remaining remedial actions at the Brookhaven Graphite Research Reactor (BGRR) and the High Flux Beam Reactor (HFBR).

The first comprehensive Five-Year Review was submitted to the regulatory agencies in July 2005, and issued as a final document in August 2006. The 2010 Five-Year Review covers all of the operable units (OUs) and Reactor-related *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) actions.

According to data reviewed from the closeout reports, the annual *BNL Groundwater Status Reports*, site inspections, and regulatory interviews, the remedies were implemented in accordance with the RODs and the two *OU III Explanation of Significant Differences* (ESD). The soil cleanup levels have been met and the groundwater remediation systems continue to meet the remedial action objectives identified in each ROD.

Since the last Five-Year Review, several additional remedy optimizations were accomplished. These include the Building 96 Tetrachloroethylene (PCE) Source Remediation, Peconic River Sediment Remediation, and improved groundwater remediation with the addition of extraction wells at the HFBR Tritium Pump and Recharge System, the OU III Chemical Holes Sr-90, BGRR/Waste Concentration Facility (WCF) Sr-90, and Airport Groundwater treatment systems.

Long-term protectiveness of the Peconic River remedy will be verified by continuing to monitor the sediment, surface water, and fish, and by completing the revegetation in areas cleaned up in the winter of 2010/2011. In addition to annual reporting of the analytical results, the effectiveness of the remedy in meeting the cleanup and restoration objectives will be evaluated during the third sitewide Five-Year Review in 2016.

For OU I, the soil excavation remedies are protective since the work was performed in accordance with the ROD, applicable design documents, and Remedial Action Work Plans. The remedies for groundwater are expected to be protective upon attainment of the groundwater cleanup goals.

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

- Remedy implementation at the BGRR and HFBR has not yet been completed.
- Work is not complete for the BGRR bioshield and final engineered cap.
- Work is not complete for the HFBR stack and Building 802 demolition.

The third comprehensive Five-Year Review in 2016 will include all OUs, the BGRR, HFBR, and the g-2/Brookhaven Linac Isotope Producer (BLIP) Tritium Plume remedy. The table below provides a summary of each OU's issues and recommendations from the 2010 Five-Year Review. The recommendations are subject to regulatory review, and implementation will be based on the availability of funding.

Table E-1: Recommendations and Follow-up Actions

Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Capture of remaining VOCs in OU I Plume	Implement pulse pumping of extraction wells. Continue pumping until 2015 to meet VOC capture goal.	BNL	DOE, EPA, NYSDEC, SCDHS	July 2011	N	N
Sr-90 in OU I Groundwater	Enhance monitoring well network to track Sr-90.	BNL	DOE, EPA, NYSDEC, SCDHS	June 2011	N	N
OU III Building 96 Source Removal Effectiveness	Continue treatment system operations. Monitor plume and determine if continuing source remains.	BNL	DOE, EPA, NYSDEC, SCDHS	September 2012	N	N
Monitoring of downgradient OU III Industrial Park East Plume	Install additional downgradient monitoring well.	BNL	DOE, EPA, NYSDEC, SCDHS	August 2011	N	N
OU III Industrial Park Treatment System Shutdown	Install additional temporary well between UVB-3 and UVB-4 in support of anticipated system shutdown.	BNL	DOE, EPA, NYSDEC, SCDHS	August 2011	N	N
OU III North Street Treatment System Shutdown	Increase system operation through 2013 due to continued high VOCs	BNL	DOE, EPA, NYSDEC, SCDHS	October 2012	N	N
OU III North Street East Treatment System Shutdown	Characterize contamination upgradient of NSE-1 and monitor for achievement of capture goal. Extend system operation through 2013 to achieve system capture goal.	BNL	DOE, EPA, NYSDEC, SCDHS	September 2011	N	N
OU III Middle Road Treatment System	Assess contamination to west of RW-1 and need for additional extraction well.	BNL	DOE, EPA, NYSDEC, SCDHS	September 2012	N	N
OU III South Boundary deep VOC contamination	Install additional extraction well(s) to capture and treat deeper contamination. Extend system operation until 2017.	BNL	DOE, EPA, NYSDEC, SCDHS	September 2012	N	N
OU III Western South Boundary TCA/Freon contamination	Extend operation of extraction well WSB-1 to 2019 to capture high TCA concentrations. Characterize extent of Freon contamination and develop path forward.	BNL	DOE, EPA, NYSDEC, SCDHS	November 2012	N	N
OU III HFBR contingency pumping termination	Determine shutdown of pump and recharge system based on characterization of high-concentration slug.	BNL	DOE, EPA, NYSDEC, SCDHS	March 2012	N	N
OU IV Sump Outfall Sr-90	Install additional monitoring wells as per *2009 Groundwater Status Report* Recommendations.	BNL	DOE, EPA, NYSDEC, SCDHS	October 2011	N	N

Continued...

Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
OU V Groundwater	Petition regulatory agencies to conclude groundwater monitoring program pending 2011 perchlorate results.	BNL	DOE, EPA, NYSDEC, SCDHS	December 2011	N	N
Potential continuing Sr-90 source at BGRR	Monitor to determine existence and assess feasibility of in-situ source stabilization. Monitor the effectiveness of new extraction wells.	BNL	DOE, EPA, NYSDEC, SCDHS	July 2012	N	N
Potential continuing Sr-90 source at Chemical Holes	Monitor to determine existence and assess feasibility of in-situ source stabilization and/or removal.	BNL	DOE, EPA, NYSDEC, SCDHS	July 2012	N	N
Peconic River Monitoring Program	Modify monitoring program following remedy optimization.	BNL	DOE, EPA, NYSDEC, SCDHS	September 2011	N	N
OU VI EDB	Add new monitoring well to bound the east side of the plume	BNL	DOE, EPA, NYSDEC, SCDHS	September 2011	N	N
BGRR Decommissioning	Complete remaining remedial actions and submit closeout report(s) to the regulators	BNL	DOE, EPA, NYSDEC, SCDHS	October 2012	N	N
HFBR	Complete remaining remedial actions and submit closeout report(s) to the regulators	BNL	DOE, EPA, NYSDEC, SCDHS	October 2011	N	N
HFBR	Explore the feasibility of reducing the 65-year safe storage (decay) period and completing the removal of large activated components earlier.	BNL	DOE, EPA, NYSDEC, SCDHS	Recurring	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, NYSDEC, SCDHS	June 2005 (survey/mapping completed 6/30/05)	N	Y
Former HWMF Perimeter Soils	Phase III - Assess soil contamination Additional cleanup if necessary	BNL	DOE, EPA, NYSDEC, SCDHS	September 2012 September 2014	N	N

Notes :

Recommendations are subject to regulatory review, and implementation will be based on the availability of funding

BGRR = Brookhaven Graphite Research Reactor
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
HFBR = High Flux Beam Reactor
NYSDEC = New York State Department of Environmental Conservation
SCDHS = Suffolk County Department of Health Services
VOCs = volatile organic compounds

OSWER No. 9355.7-03B-P

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: John Sattler

Author title: DOE Federal Project Director and IAG Remedial Project Manager | **Author affiliation:** U.S. DOE, Office of Environmental Management, Upton, NY

Review period:** 7/19/2005 to 12/31/2010

Date(s) of site inspection: 6/15/10 through 11/18/10

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)*: 7/19/2006

Due date *(five years after triggering action date)*: 7/13/2011

* ["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
Table of Contents

Table of Contents *(Continued)*

List of Tables

List of Figures

Table of Contents *(Continued)*

List of Attachments

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	below-ground 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	U.S. Department of Energy
DQO	Data Quality Objective
EDB	ethylene dibromide
EPA	U.S. 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
NEPA	National Environmental Policy Act
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 31 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. NYSDEC 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 potential problems with the ability of the remedial actions to meet the cleanup objectives, if any, and provide 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 Protection Division (EPD) and Environmental Restoration Projects (ERP) conducted this Five-Year Review of the remedial actions implemented at the BNL site under the direction of the DOE Remedial Project Manager. This report documents the results of the review.

This is the second sitewide Five-Year Review for the BNL site and includes all the Operable Units (OUs), the Brookhaven Graphite Research Reactor (BGRR), the High Flux Beam Reactor (HFBR), and the g-2 Tritium Plume and Brookhaven Linac Isotope Producer (BLIP) Areas of Concern (AOCs). The triggering action for this 2010 sitewide statutory Five-Year Review is the completion of the first sitewide review in July 2006. This review is required because hazardous substances, pollutants, or contaminants at the site are above levels that allow for unlimited use and unrestricted exposure. This second sitewide Five-Year Review includes an evaluation of all the AOCs at BNL. Previous Five-Year Reviews were:

- Five-Year Evaluation Reports prepared for the Current and Former Landfills in 2001 and 2002 in accordance with New York State Part 360 requirements (BNL 2001a and 2002).
- A Five-Year Review focused specifically on the OU IV remedy in September 2003 (BNL 2003a).
- The first sitewide Five-Year Review submitted as draft to the regulators in July 2005, with the final Report issued in July 2006. The triggering action for this review was initiation of the remedial action for OU I contaminated landscape soils in July 2000. This Review did not include the g-2/ BLIP or HFBR RODs.

2.0 Site Chronology

Remedial actions at the BNL site are currently being addressed under RODs for six OUs, the BGRR, the HFBR, and g-2/BLIP, covering 31 AOCs. The chronology in **Table 2-1** first identifies general site information, and then breaks each OU down by major event. **Table 2-2** presents each OU and Removal Action AOC.

Table 2-1: 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	
RA for BLIP Facility (AOC 16K) cap, drainage control, grout injection; Closeout Report issued	1998/2002
Remedial Investigation (RI); RA Report issued	1999
Evaluation of alternatives included under OU I Feasibility Study (FS)	1999
Operable Unit III	
RA for Building 479 PCB-contaminated soil excavation	1992
RA for Building 464 mercury-contaminated soil excavation	1993
RA for cesspools/septic tanks completed; Closeout Report issued	1994–1999
RA for USTs completed; Closeout Report issued	1994–1999
RA for public water hookups	1996–1998
RA for South Boundary groundwater treatment system construction	1997
RA for High Flux Beam Reactor (HFBR) tritium plume groundwater treatment system	1997
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

Continued…

Table 2-1: Chronology of Site Events *(continued)*

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 and off-site disposal of Building 96 PCB-contaminated soil; Closeout Report issued	2005
Explanation of Significant Differences (ESD) issued for Magothy, Sr-90, Bldg. 96 geophysical anomalies	2005
Building 96 Groundwater Treatment System Shutdown Petition Issued	2005
Completed construction of additional extraction wells for the HFBR, Chemical Holes, and Airport groundwater treatment systems	2007
Explanation of Significant Differences (ESD) issued for Bldg. 96 VOC soil excavation	2009
Petition approved for shutdown of the Industrial Park East groundwater treatment system	2009
Petition approved for closure of the Carbon Tetrachloride groundwater treatment system; system dismantled	2009-2010
Completed excavating and off-site disposal of Building 96 VOC-contaminated soil	2010
Completed construction of additional extraction wells for the WCF Sr-90 groundwater treatment system	2011
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	2003/2004
RA for Peconic River sediment excavation on site (Phase 1); Completion Report issued	2004/2005
RA for Peconic River sediment excavation off site (Phase 2); Completion Report issued	2004/2005
ROD signed for Peconic River	2005
Closeout Report for Peconic River Phase 1 and 2 Remediation issued	2005
Initiated post-cleanup Peconic River monitoring program to demonstrate the effectiveness of the cleanup	2006
Completed ROD-required sediment trap removal and Peconic River remedy optimization	2011
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
Graphite pile removal; Closeout Report issued	2010
Biological shield removal	In Progress
Engineered cap installation	In Progress

Continued...

Table 2-1: Chronology of Site Events *(continued)*

g-2/BLIP/USTs	
Impermeable caps placed over BLIP and g-2 source areas	1997 and 1999
Groundwater monitoring, cap inspections and maintenance	1999-2010
ROD signed	2007
High Flux Beam Reactor	
Dismantlement and removal of several ancillary buildings	2006
RA completed for excavating former HWMF Waste Loading Area soils; Completion Report issued	2007-2009
ROD signed	2009
Removal of Bldg. 801-811 underground waste transfer lines (A/B waste lines with co-located piping) and associated soil; Closeout Report issued.	2009
RA for removal/disposal of control rod blades and beam plugs; Completion Report issued	2009-2010
Began Long-Term Surveillance and Maintenance (S&M)	2010
Fan house (Bldg. 704), above- and below-ground structures, and associated soil removal	2010
Confinement Building stabilization	2010
Underground utilities and associated soil removal	In Progress
Stack and Bldg. 802 fan house demolition	In Progress
Other Actions	
RA completed for excavating the former HWMF Phase I Perimeter Soils; Completion Report issued	2009
Completed excavating the former HWMF Phase II Perimeter Soils; Completion Report Addendum issued	2010

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
EDB = ethylene dibromide
ESD = Explanation of Significant Differences
FS = Feasibility Study
HWMF = Hazardous Waste Management Facility
IAG = Interagency Agreement
LIPA = Long Island Power Authority
NYSDEC = New York State Department of Environmental Conservation
RA = Removal Action
RI = Remedial Investigation
ROD = Record of Decision
S&M = Surveillance and Maintenance
STP = Sewage Treatment Plant
USTs = underground storage tanks
VOC = volatile organic compound
WCF – Waste Concentration Facility

Table 2-2 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
	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	Former and Current Landfill Closures – removal actions 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 – 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 ongoing
	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 ongoing
	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 ongoing
	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 16R	Aerial Radioactive Monitoring System results– Nuclear Waste Management Facility, Building 830 – complete (covered under AOCs 11 and 12)
	AOC 18	AGS Scrapyard (groundwater) – groundwater monitoring ongoing
	AOC 19	TCE Spill Area, Building T-111 – groundwater monitoring ongoing
	AOC 20	Particle Beam Dump, north end of Linac (includes Basin HT) – monitor and maintain per SPDES permit/*Natural Resource Management Plan* (NRMP)
	AOC 21	Leaking sewer pipes (sitewide, not investigated under other OU study areas) – groundwater monitoring ongoing
	AOC 22	Old Firehouse – no further action per ROD
	Sub AOC 24A	Process Supply Wells 104 and 105 – treatment systems operating, groundwater monitoring ongoing
	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 2-2 Operable Unit (OU) AOCs *(continued)*

Category	AOC #	Description and Status
	AOC 25	Building 479 PCB soil removal complete; groundwater monitoring underway
	AOC 26	Building 208 – removal action complete
	AOC 26A	Building 208 (groundwater) - groundwater monitoring complete
	AOC 26B	Former Scrapyard/Storage Area south of Bldg. 96 – treatment system operating; soil removal complete
	AOC 27	Building 464 mercury soil removal complete; groundwater monitoring ongoing
	AOC 29	Spent fuel pool in HFBR and associated groundwater plume of tritium – pump and recharge system operating; groundwater monitoring ongoing
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 ongoing
OU V – Peconic River (ROD Approved)	AOC 30	Peconic River – cleanup on and off of BNL property complete; additional sediment removed in 2010/2011; river monitoring ongoing
OU VI (ROD approved)	AOC 28	EDB groundwater contamination – treatment system operating, groundwater monitoring ongoing
BGRR (ROD Approved)	AOC 9	Graphite Pile – complete
		Biological Shield/Engineered Cap – in progress
	AOC 9A	Canal – complete
	AOC 9B	Underground duct work – complete
	AOC 9C	Spill sites – complete
	AOC 9D	Pile Fan Sump – complete
g-2 and BLIP (ROD Approved)	AOC 12	Underground Storage Tanks, Bldgs. 462, 463, 527, 703, 927, 931B – complete
	AOC 16K	Aerial Radioactive Monitoring System results – BLIP, Building 931B – Source area protection and groundwater monitoring ongoing
	AOC 16T	Aerial Radioactive Monitoring System results - g-2 Source Area and Tritium Groundwater Plume – source area protection and groundwater monitoring ongoing
HFBR (ROD Approved)	AOC 31	Waste Loading Area – complete
		Control Rod Blades and Beam Plugs – complete
		Building 801-811 Waste Transfer Lines - complete
		HFBR Stabilization – complete; Closeout Report in review
		Fan Houses (Buildings 704 and 802) – in progress
		Underground Utilities – in progress
		Stack – in progress
Other Removal Action	Not applicable	Former HWMF Perimeter Soils – Phase I – complete; Phase II – complete; Phase III – pending
	Not applicable	Central Steam Facility Lead-Contaminated Soil – complete

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 compound

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 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 a depth of 45 to 1,500 feet below the land surface. These three water-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 and Institutional Controls

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, former Hazardous Waste Management Facility (HWMF), Sewage Treatment Plant (STP), firebreaks, and former landfill areas. A significant portion of land on the eastern portion of the site has been designated as the Upton Ecological Reserve. DOE is also leasing approximately 200 acres of land on the east and southeast portion of the site to BP Solar for the development of a 32 megawatt (MW) direct current solar power plant.

The current land-use designations for the BNL site as of March 2010 are shown on **Figure 3-1**. This includes industrial use in the central portion of the site, with open space borders. Although not shown on this map, 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 (https://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)
- Sensitive Areas, Biologically/Culturally Sensitive - Restricted Land Use (G)

Institutional controls are administered as per the *BNL Land Use Controls Management Plan* (LUCMP) (BNL 2009e, Rev. 3) which was initially issued in 2003. LUICs will be maintained for as long as necessary in order to ensure performance of the completed remedies as described and documented in the BNL RODs. The AOC-specific institutional controls are documented on fact sheets stored on the *BNL Land Use and Institutional Controls* (LUIC) website (https://luic.bnl.gov/website/landcontrols/). This is a secure website that is available for regulatory use but is not open to the general public. The website is BNLs tool for internally managing Institutional Controls (ICs) and consists of an interactive Graphic Information Systems (GIS) base map that is linked to the AOC-specific fact sheets. Planning for any work at the site that may potentially disturb a formerly remediated area requires a review of the website. ICs 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 by BNL and reviewed by the regulators in an effort to stay current with evolving management techniques. The Plan was updated three times since 2005 with the latest update in June 2009 (BNL 2005d, 2007a and 2009e). LUICs are evaluated from a sitewide standpoint on an annual basis and issues from the previous year are summarized in a letter report to the regulatory agencies. A summary of findings from the required annual inspections of former AOCs is included in this report. The Plan also details notification criteria in the event of a LUIC breach or unauthorized change in land use. Specific ICs for each area are detailed in the fact sheets and are summarized by OU in **Section 7.0** of this Report.

Because of chemical contamination in the Upper Glacial aquifer, DOE provided public water hookups for homes in the area south of BNL. 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 (four in OU III, one in OU V, and three in OU VI). 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 to when the site was an Army training camp, 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], tetrachloroethylene [PCE], 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 BNL 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, the BGRR, g-2/ BLIP/underground storage tanks (USTs), and the HFBR covered under this Five-Year Review are as follow:

- 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 identified as part of aerial radiological surveys. The AOCs in this OU were documented under the OU I and III RODs (except for BLIP [AOC 16K] which was documented in a separate ROD).

- OU III – Groundwater contaminated with VOCs such as carbon tetrachloride, 1,1,1-trichloroethane (TCA), and PCE, and radionuclides such as tritium and Sr-90 on BNL property; VOC-contaminated groundwater off of BNL property including PCE and carbon tetrachloride; and PCE soil contamination at one location on BNL property.
- 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. Groundwater contaminated with Sr-90 located in central portion of BNL property.
- OU V – Radiological- and metal-contaminated soil at the Sewage Treatment Plant (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 – Activated components including the pile and bioshield, radiologically contaminated soils, sumps, ducts, piping, and standing water including Cs-137 and Sr-90; and Sr-90 in groundwater on the BNL site.
- g-2/BLIP/USTs – Radioactive soil shielding and contaminated groundwater at the g-2 and BLIP experiment areas, and removal of underground storage tanks.
- HFBR – Activated components, contaminated structures, systems, underground pipes/ducts, ancillary buildings and associated soils. Tritium-contaminated groundwater.

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, NYSDEC, 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 (NYSDOH) 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 31 AOCs and six OUs at the BNL site.

As noted in **Table 2-1** in **Section 2.0**, 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 and HFBR. 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

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

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

<u>Soils:</u> The former HWMF (AOC 1) contained most of the radioactively contaminated soil at BNL. The predominant radionuclide was Cs-137, which is the primary source of risk from direct exposure. Sr-90 was

also present, and most of the contamination was at or near the surface although in some locations it extended to 12 feet below grade. Other contaminated soil areas included 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 that were unknowingly once used for landscaping purposes. The Former (AOC 2), Interim (AOC 2D), and Current (AOC 3) landfills, as well as the Chemical/Animal Pits and Glass Holes (AOC 2B and 2C), received waste generated at the BNL site from 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 groundwater beneath the Current Landfill contains VOCs and metals. Sr-90 and VOCs have also entered the groundwater from the former HWMF. 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 Cs-137 soil contamination in the landscape soils was found greater than 2 feet below grade. This soil contamination was included under the OU I project. 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 (see discussion on g-2 and BLIP areas below).

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

Groundwater: VOC-contaminated groundwater extends south from the central portion of BNL off site to the Brookhaven Airport area, a distance of approximately three miles. The VOC plumes originated from a variety of sources including various small spill areas in the central industrial/research areas of the site, former Building 96, the Former Landfill, the Central Steam Facility (OU IV), Former Building 208 warehouse area, and the former Carbon Tetrachloride UST. The primary contaminants are TCA, PCE, and carbon tetrachloride. Tritium and Sr-90 are also present above the maximum contaminant levels (MCLs) on the BNL site. There is no radiological contamination off of BNL property that exceeds MCLs. 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. Although these plumes were not found to have impacted any off-site private drinking water supply wells, in the 1990s DOE provided public water connections to most of the homes located in North Shirley. Although eight homeowners elected to continue to use their private wells for drinking water purposes, DOE offers free annual testing of their well water, which is conducted by the SCDHS.

Soils: PCB-contaminated soils above the New York State Technical and Administrative Guidance Memorandum (TAGM) cleanup levels, as well as high concentrations of PCE in soil were found at the former Building 96 Scrapyard (AOC 26B). Other smaller contaminated soil 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. 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 were also present in the soils from the historical oil/solvent spill. Radiological contamination of soils was identified at the Building 650 Sump Outfall. This soil contamination was included under the OU I project.

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

Soil/Sediment: The STP berms soil (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 the PCB Aroclor-1254. Trace amounts of Cesium-137 were co-located in the sediment, but did not pose a risk to people or aquatic organisms.

Groundwater: VOCs (e.g., TCE) were the primary contaminants in the groundwater on and off of the BNL site. Low levels of tritium were also found, but at concentrations below the 20,000 picoCuries per liter (pCi/L) MCL.

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 MCL of 0.05 micrograms per liter (µg/L). The EDB originates from application in the Biology Fields in the 1970s.

BGRR

Structures and Soils: There are several radiologically contaminated and activated structures and components 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 below-ground 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. Concerns also include rainwater infiltration and subsequent leaching into the soil/groundwater. Most nonradiological hazardous materials associated with the BGRR were 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 MCL. The Sr-90 contamination extends up to 1,500 feet south of this area.

g-2/BLIP/USTs

Structures and Soils: The former g-2 experiment area (AOC 16T) and BLIP facility (AOC 16K) contain soil 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 activated soils, and the leaching of tritium and sodium-22 into the groundwater. To reduce the ability of rainwater to infiltrate the activated soils, a number of stormwater management controls have been implemented. In addition, eight underground storage tanks from several locations across the site were removed between 1988 and 1996, and confirmatory soil sampling following the tank removals indicated no environmental impacts.

Groundwater: Groundwater in the vicinity of the former g-2 experiment area (AOC 16T) and BLIP facility (AOC 16K) has been contaminated with tritium at concentrations that exceeded the 20,000 pCi/L MCL. Although sodium-22 concentrations occasionally exceed the 400 pCi/L MCL, it decays to nearly non-detectable levels within a short distance from the source areas. There are no groundwater impacts associated with the former USTs.

HFBR

Activated Components, Contaminated Structures and Soils: Past operations resulted in the formation of radioactive material (i.e., activation products) within the metal and concrete of the large reactor components (reactor vessel/internals, thermal shield and biological shield). Smaller quantities of radioactive material were also found in ancillary structures (fan houses and stack), underground pipes/ducts, and associated soils.

Groundwater: Groundwater contaminated with tritium, included under OU III, is present in the vicinity of the HFBR complex and extends discontinuously up to several thousand feet to the south, at concentrations above the 20,000 pCi/L MCL. Tritium has not been detected above the MCL beyond the BNL property boundary.

4.0 Remedial Actions

4.1 Remedy Selection

To date, nine Records of Decision have been signed at BNL. The first was signed in 1996 and the last in 2009. The nine RODs are:

1. OU I – Radiologically 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 – Radiologically contaminated structures and soil on site
8. g-2/BLIP/USTs – Radiologically contaminated soil shielding and groundwater
9. HFBR – Radiologically contaminated structures and soil

Individual site locations are shown on **Figure 4-1**. Brief descriptions of the ROD remedial action objectives and the major remedy components are described below.

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

- 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 soils 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 Pits and Glass Holes, and dispose of soil at an approved off-site 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 sediment at an approved facility off the BNL site. 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, and 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 were 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 and groundwater at BLIP is documented in the g-2/ BLIP/USTs ROD (BNL 2007b).

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

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

- Objectives are to:
    - Meet drinking water standards (i.e., maximum contaminant levels [MCLs]) in groundwater for VOCs, Sr-90, and tritium.
    - Complete cleanup of the groundwater in the Upper Glacial aquifer within 30 years (by 2030) or less.
    - Prevent or minimize further migration of VOCs, Sr-90, and tritium in groundwater.
- OU III Remedy Components:
    - For VOCs – Install treatment systems 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 at the HFBR 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 (see OU III ESD below).
    - 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 former Carbon Tetrachloride UST 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) was documented 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.

Operable Unit III Explanation of Significant Differences, signed May 2005 (BNL 2005a)

- OU III 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 of the signing of the OU III ROD (by 2065).
    - Sr-90 – Continue to operate the “pilot study” remediation facility treatment system at the Chemical Holes and meet the drinking water standards within 40 years (by 2040). Install an ion exchange treatment system for the BGRR/WCF plume, and meet the drinking water standards within 70 years (by 2070).
    - 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 III Explanation of Significant Differences, signed August 2009 (BNL 2009a)

- OU III Remedy Components:
    - Building 96 Scrapyard – Changes to the Building 96 groundwater remedy to include excavation and off-site disposal of PCE-contaminated soils. This will optimize the remedy by reducing the number of years of active treatment and enable BNL to achieve the ROD cleanup goal for this groundwater plume (by meeting drinking water standards for volatile organic compounds by 2030).

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 as discussed above.
    - Monitor the natural attenuation of Sr-90 contamination in groundwater originating from the former Sump Outfall area.

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

- 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 and 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 soil at an approved off-site 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.

<u>Operable Unit V Peconic River ROD, signed January 2005 (BNL 2004a)</u>

- 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:
  - 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 methylmercury in the water-column, sediment sampling, and fish sampling on and off of BNL property.
  - Conduct an annual review for the first five years after commencement of the remedial action to ensure that the remedies continue to provide adequate protection of human health and the environment.
  - Sampling results for each annual review and the formal Five-Year Review will be evaluated with the regulators, and appropriate modifications will be made, as necessary, for subsequent sampling.

<u>Operable Unit VI ROD, signed March 2001 (BNL 2000b)</u>

- Objectives are to:
  - Meet the MCL 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 (by 2030) 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.
  - Develop 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.

<u>BGRR ROD, signed March 2005 (BNL 2005b)</u>

- 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 (i.e., engineered cap) and monitoring system (including the installation of groundwater monitoring wells) 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.
  - Submit 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.

g-2/BLIP/USTs ROD, signed May 2007 (BNL 2007b)

- Objective is to:
  - Prevent additional rainwater infiltration into activated soil shielding at g-2 and BLIP.
- g-2/BLIP/USTs Remedy Components:
  - Inspect and maintain the caps and other stormwater controls at the g-2 and BLIP source areas. Submit 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.
  - Conduct routine groundwater monitoring to verify the effectiveness of the stormwater controls. Monitor the downgradient portion of the g-2 plume until tritium concentrations decrease to below the 20,000 pCi/L MCL.
  - For the former UST areas, no additional remedial actions are required.

High Flux Beam Reactor ROD, signed April 2009 (BNL 2009b)

- Objectives are to control, minimize, or eliminate:
  - All routes of future human and/or environmental exposure to radiologically contaminated facilities or materials.
  - The potential for future release of non-fixed radiological or chemical contamination to the environment.
  - All routes of future human and/or environmental exposure to contaminated soils.
  - The future potential for contaminated soils to impact groundwater.

- HFBR Remedy Components:

  The HFBR remedy incorporates many completed interim actions, several near-term actions, and the segmentation, removal, and disposal of the remaining HFBR structures, systems, and components following a safe storage decay period (not to exceed 65 years).

  Completed interim actions:
  - The HFBR fuel was removed and sent to an off-site facility.
  - The primary coolant was drained and sent to an off-site facility.
  - Scientific equipment was removed and is being reused.
  - Shielding and chemicals were removed and are being reused at BNL and other facilities.
  - The cooling tower superstructure was dismantled and disposed of.
  - The confinement structure and spent fuel canal were modified to meet Suffolk County Article 12 requirements.
  - The Stack Monitoring Facility (Building 715) was dismantled and disposed of.
  - The Cooling Tower Basin and Pump/Switchgear House (Building 707/707A) was dismantled and disposed of.
  - The Water Treatment House (Building 707B) was dismantled and disposed of.
  - The Cold Neutron Facility (Building 751) contaminated systems were removed and the clean building has been transferred to another organization for re-use.
  - The Guard house (Building 753) was dismantled and disposed of.
  - Soil excavation and disposal of the former HWMF Waste Loading Area (WLA) was performed.
  - Control rod blades and beam plugs were removed and disposed of.

  Near-term Actions:
  - Removal of ancillary buildings and associated soils.
    - Stack (Building 705)
    - Fan houses (Buildings 704 and 802)
  - Removal of contaminated underground pipes and ducts.
  - Preparation of Reactor Confinement Building (Building 750) for safe storage.

  Removal after Safe Storage Decay Period:
  - Large activated components (reactor vessel and internals, thermal shield and biological shield).
  - Reactor Confinement Building structures, systems and components.
  - Cleanup of associated soils.

In addition, the final remedy specifies the requirements for surveillance and maintenance to manage the inventory of radioactive material during the safe storage period. Land use and institutional controls, including periodic certification to EPA and NYSDEC, are also specified.

4.2 Remedy Implementation

With the exception of the removal of the biological shield and installation of the engineered cap for the BGRR, and the decommissioning and decontamination (D&D) of the remaining HFBR structures (e.g., stack), systems, and components, all soil, groundwater, and D&D remedies for the nine signed RODs at the site have been implemented. This includes the excavation and approved off-site disposal of all contaminated soil, sediment, and tanks, the installation and operation of all groundwater treatment systems, and Long-Term Surveillance and Maintenance of the BGRR and HFBR. A chronology of the previous removal actions undertaken for each OU, and post-ROD remedial actions, is presented in **Table 2-1** (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 radiologically 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 were disposed of at Envirocare of Utah, and 2,500 cubic yards were disposed of at Niagara Falls Landfill Facility. (Furthermore, approximately 11,000 cubic yards of soil were excavated from the Chemical/ Animal Pits and Glass Holes during 1997 as part of a Removal Action that was conducted prior to the ROD being signed.) In 2003, the ash pits were capped with a soil cover to prevent direct contact risks, 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 that the cleanup effort at these radiologically contaminated soils areas attained the cleanup goals defined in the ROD. Closeout reports were issued for the landscape soil, Building 650 and Sump Outfall, Upland Recharge/Meadow Marsh, the former HWMF, and Building 811 soil, and an addendum to the existing Chemical Holes Closeout Report was also issued. In March 2007, the decontamination of the Merrimack Holes at the former HWMF was completed.

As noted in the *Final Closeout Report for Area of Concern 16 Landscape Soils* (BNL 2001c), monitoring conducted after the calendar year 2000 and the excavation of the landscape soil indicates that the potential exposure to workers and future site residents is less than the 15 milliRem (mRem)/year above background criteria.

Operable Unit III: Fourteen of BNL's 16 groundwater treatment systems are included under OU III. Following the signing 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, for a total of 14 systems. 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 Reports.* Through 2009, the OU III treatment systems have removed 6,045 pounds of VOCs from the aquifer, a total of 6,433 pounds have been removed by all of the treatment systems.

In accordance with the ROD, several low-flow extraction events were performed between 2000 and 2001 for the high-concentration segments of the HFBR tritium plume. Approximately 100,000 gallons of tritium-contaminated water were pumped from the aquifer and disposed of at an approved off-site facility. Contingency remedies continue to remain in place for the HFBR tritium plume. In response to the November 2006 triggering of the OU III ROD contingency plan, the HFBR Pump and Recharge system was re-started in December 2007. As part of this action, a new extraction well was constructed to improve control and capture of the plume. This well began operation in November 2007 and currently remains in operation.

The regulatory agencies approved Petitions for Shutdown of the Carbon Tetrachloride, Building 96, and Industrial Park East treatment systems in 2004, 2005, and 2009, respectively. These systems were subsequently turned off and placed in standby mode. However, in 2008, the Building 96 groundwater treatment system was turned back on and Well RTW-1 was modified from a recirculation well to surface discharge of the effluent due to a rebound of VOC concentrations in source area monitoring wells. Subsequent investigations identified a localized source of VOC contamination within vadose zone. In accordance with the OU III ESD approved in 2009, the VOC-contaminated soils were excavated in 2010 and disposed of at an approved off-site facility. Hexavalent chromium was also detected in Building 96 area monitoring wells in 2008 as a byproduct of potassium permanganate injections. The well RTW-1 modification also included treatment for the hexavalent chromium. Following regulatory agency approval for closure in October 2009, the Carbon Tetrachloride treatment system was dismantled in 2010.

Between 1999 and 2005, approximately 2,200 cubic yards of PCB-contaminated soil from the former Building 96 Scrapyard area were excavated and disposed of off site. This was accomplished in accordance with the ROD to reduce the risk of direct contact with contaminated soils in 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 the LIPA and Industrial Park East treatment system areas. Between 2007 and 2010, additional extraction wells were installed at the LIPA/Airport, Chemical Holes Sr-90, HFBR Tritium Pump and Recharge, and BGRR/WCF Sr-90 systems. These additional extraction wells were necessary to address changing plume conditions identified as part of the long-term groundwater monitoring program.

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/solvent spill area. A CERCLA Five-Year Review performed for OU IV in 2003 (BNL 2003a) found that the remedy was highly effective in remediating soil and groundwater contamination. The system met its cleanup objectives and the regulatory agencies approved its dismantlement in 2003.

Operable Unit V: Following issuance of the OU V STP ROD (BNL 2001b), the contaminated soil at the plant was excavated and disposed of off site in 2003. A closeout report for this effort was issued in 2004 (BNL 2004b). Prior to issuance of the OU V Peconic River ROD (BNL 2004a), the excavation of on- and off-site contaminated sediments in the River (approximately 21,000 cubic yards) was performed in 2004 and 2005 under the authority of a Removal Action (BNL 2004c). The closeout report for the Peconic River Phases 1 and 2 was issued in 2005 (BNL 2005c). Based on Peconic River monitoring data collected between 2005 and 2009, the need for supplemental sediment removal in the River was determined necessary by DOE and the regulatory agencies. In late 2010/early 2011, an additional 800 cubic yards of contaminated sediment were excavated. A draft Completion Report will be submitted to the regulatory agencies in the spring of 2011. Natural attenuation monitoring of the low-level VOC groundwater plume that originated from the STP area continues.

Operable Unit VI: In 2004, a groundwater treatment system was installed in accordance with the OU VI ROD, and began operations to remediate the plume of EDB located beyond the site boundary. This was the last of the planned systems to be installed beyond the BNL 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 at the BGRR prior to the ROD approval in 2005 were conducted through removal actions or *National Environmental Policy Act* (NEPA) categorically excluded actions. Since ROD approval, the cleanup actions at the BGRR (e.g., removal of the graphite pile) were performed as remedial actions under the ROD (BNL 2005b). Remedial activities associated with the Graphite Pile Removal Project commenced in December 2009 and were completed in May 2010. The following summarizes the scope of activities:

- Removal and Disposal of Control Rods.
- Removal and Disposal of Boron Shot.
- Removal and Disposal of Shield Plugs.
- Removal and Disposal of upper portion of Air Tight Membrane.
- Removal and Disposal of Invar Rods.
- Removal and Disposal of Graphite Pile.

Removal of the biological shield and installation of the final engineered cap are in progress.

g-2/BLIP/USTs: BNL routinely inspects and maintains the caps and other stormwater controls at the g-2 and BLIP source areas. Routine groundwater monitoring is conducted to verify the effectiveness of the stormwater controls. The downgradient portion of the g-2 plume is monitored using permanent and temporary wells. For the former UST areas, no additional remedial actions are required.

HFBR: Prior to the ROD approval in 2009, all of the cleanup actions at the HFBR were performed through removal actions or *National Environmental Policy Act* (NEPA) categorically excluded actions. Since ROD approval, stabilization of the reactor confinement building for safe storage and the cleanup actions at the HFBR, such as the removal of Building 801-811 waste transfer lines (A/B waste lines with co-located piping) and associated soil, was performed as remedial actions under the ROD (BNL 2009b). Other remedial actions associated with the removal of ancillary structures (e.g., fan houses and stack) and underground utilities (e.g., pipes and ducts) are in progress.

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. Comprehensive summaries of the annual monitoring and evaluations of the systems and plumes are documented in quarterly progress reports and the annual *BNL Groundwater Status Reports* (Volume II of the *BNL Site Environmental Report*). Recommendations are made on an annual basis for modifications to groundwater monitoring programs in response to changing plume conditions. These recommendations are developed with regulatory agency input. The treatment systems and monitoring programs are optimized with the goal of meeting drinking water standards within 70 years (2070) for the BGRR/WCF Sr-90 plume, within 65 years (2065) for the Magothy aquifer, within 40 (2040) for the Chemical Holes Sr-90 plume, and within 30 years (2030) for VOCs in the Upper Glacial aquifer.

Property Access: Eight access agreements are currently in place with the county, town, local utility, college, and private landowners. Seven of these agreements enable BNL to perform groundwater remediation activities for contamination that has migrated beyond the property boundary of BNL. The eighth agreement is with Suffolk County and allows for the supplemental remediation of the Peconic River sediment. 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 of the planned groundwater treatment systems have been constructed. The first system became operational in January 1997, and the last system was placed in service in mid 2005. The location of each of the treatment systems and their operational status is shown on **Figure 4-2**. The operational status of each of the extraction wells is provided on **Figure 4-3**. The OU IV and Carbon Tetrachloride systems met their cleanup goals and were dismantled, and the Industrial Park East system is in standby mode awaiting closure. (The Industrial Park system can be restarted if concentrations rebound.) The remaining 13 systems are in active operation. 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 (BNL 2002-2009). The O&M Manuals are updated as needed to reflect changes to the treatment systems, such as the installation of additional extraction wells. BNL performs routine inspections and maintenance of these systems.

Groundwater has been extracted from the Upper Glacial and Magothy aquifers using 61 wells. Currently, 15 of these wells are in standby mode, 10 are in pulse pumping mode, and 3 were recently decommissioned (i.e., abandoned by sanding and grouting the well in place). Average individual extraction well flow rates range from approximately 5 gallons per minute (gpm) for the Sr-90 systems to up to 450 gpm for some of the VOC systems. System treatment for VOCs consists primarily of air stripping or carbon adsorption. Ion exchange is used for the Sr-90 groundwater contamination. To monitor system performance, the influent, midpoint (if appropriate), and effluent are routinely sampled. Treated water from the systems is returned to the Upper Glacial aquifer via recharge basins, injection wells, or dry wells. These discharges are regulated by New York State Pollutant Discharge Elimination System (SPDES) discharge equivalency permits.

The annual O&M costs for the treatment systems during 2005-2009 were as follow:

Table 4-1: System O&M Costs for FY 2005 to 2009

			($ in K)			
System	FY05	FY06	FY07	FY08	FY09	Comments
OU I South Boundary	98	104	93	102	94	Air stripping
OU III South Boundary/ Middle Road	222	312	155	173	249	Air stripping
OU III Industrial Park	340	301	372	344	343	Uses in-well air stripping with vapor-phase carbon treatment, with recirculation wells
OU III Building 96	133	74	23	295	139	Air stripping treatment. Three of four wells in standby FY06-07. Modified well RTW-1 in FY08 and added hexavalent chromium treatment.
OU III Carbon Tetrachloride	12	10	10	7	24	In standby mode since 2004
OU III Western South Boundary	101	48	55	145	158	Air stripping treatment. Pulse pumped in FY06-07, additional characterization in FY08-09.
OU III Industrial Park East	149	168	131	44	34	Carbon treatment, began pulse pumping in FY08
OU III North Street/ North Street East	375	381	367	353	401	Carbon treatment
OU III Airport/LIPA	550	511	491	259	334	Carbon treatment
OU III HFBR Tritium	207	171	237	237	185	Pump and recharge. Includes annual temporary wells.
OU III Sr-90 Chemical Holes	270	215	274	156	114	Ion-exchange treatment
OU III Sr-90 BGRR/WCF	550	544	335	306	356	Ion-exchange treatment
OU VI EDB	192	131	197	220	219	Carbon treatment

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. These are direct costs of operation and do not include, monitoring well sampling and analysis, project oversight and project management costs.

5.0 Progress Since the Last Review

This is the second sitewide Five-Year Review for the BNL site that covers all of the OUs. The protectiveness statement for each OU, the BGRR, the HFBR, and progress in accomplishing the cleanup goals since the previous Five-Year Review (BNL 2006a) are:

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.

Soil Remediation:

- Decontamination of the Merrimack Holes at the former HWMF was completed in July 2006.
- Stormwater controls and re-vegetation of the former HWMF have been improved since the soil remediation effort was completed in 2005.

Groundwater Remediation:

- Hydraulic control of the VOC plumes is being accomplished by the OU I South Boundary treatment system. The off-site segment of the plume is controlled by the North Street East system (discussed under OU III). The South Boundary treatment system, capping of the Current Landfill, remediation of the former HWMF, and natural attenuation have all contributed to a significant reduction in the overall extent and concentrations of the VOC plume, as shown on **Figure 5-1**. The operational duration of the extraction wells at the south boundary is being extended from the planned shutdown in 2011 to 2015 due to the slower than expected migration of an area of elevated VOC concentrations located approximately 500 feet to the north. The reduced migration rates appear to be due to plume migration through a zone of lower permeability materials (the Upton Unit) that characterize the deep section of the Upper Glacial aquifer in this area of the site. Extending the operational duration of the two extraction wells will ensure that the area of elevated VOCs is captured and treated, and that the ROD cleanup goals are achieved.
- An area of Sr-90 contamination in the Upper Glacial aquifer south of the former HWMF that was originally identified in 2001 was re-characterized during 2010 using temporary wells. This effort was to assess the potential for Sr-90 to reach the site boundary at concentrations above the 8 pCi/L MCL. Updated groundwater modeling using the 2010 characterization data predicts that Sr-90 concentrations will be less than the 8 pCi/L MCL upon reaching the site boundary.
- Groundwater quality downgradient of the capped landfills continues to improve. VOCs were not detected above MCLs at the Former Landfill over the previous two years. In addition, monitoring for the Former Landfill indicates that there is no longer significant leachate being generated. Several VOCs continue to be detected at levels above MCLs at the Current Landfill along with evidence of low-level leachate generation.

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

- The extent of the high-concentration segments of the OU III VOC plumes has decreased both on and off site as the result of groundwater remediation system operations and the effects of natural attenuation (see **Figure 5-1**).
- In 2007, an additional extraction well was installed for the Airport treatment system to allow for the capture and treatment of carbon tetrachloride contamination that was migrating further to the west than originally anticipated during the design of the system. The rest of the Airport extraction wells show very low VOC concentrations and are currently being operated in a pulse pumping

mode. These wells can be returned to full-time operations in the event VOC concentrations are observed to significantly increase.

- The Western South Boundary system is remediating an area of elevated VOC concentrations. In 2008, an area of higher than expected concentrations of TCA was characterized between Middle Road and South Boundary extraction well WSB-1 (which had previously been placed in standby mode). Monitoring of this contamination continues, and full-time operation of WSB-1 has resumed, insuring the capture of the TCA slug as it migrates to the site boundary. It is expected that the operation of this extraction well will need to be extended until approximately 2019 in order to completely capture the TCA slug and allow the system to achieve the ROD cleanup goal. An area of higher than expected Freon was also detected by the monitoring program in 2008, and characterization is ongoing to determine its extent.
- The Industrial Park East system was placed in standby mode in 2009 following regulatory approval of a petition to shutdown the system. BNL will continue to monitor the predicted natural attenuation of a small area of elevated VOC concentrations in the Upper Magothy aquifer that is positioned south of the extraction wells.
- The excavation of PCE-contaminated soils at the former Building 96 area was completed in late 2010. It is anticipated that the treatment system will have to be operated full-time for another three to six years (2013 – 2016) in order to achieve the capture goal (50 µg/L) and allow for it to be placed in standby mode. As noted in **Section 4.2**, extraction well RTW-1 modification in 2008 also included treatment for hexavalent chromium. Due to reduced hexavalent chromium in the monitoring wells and RTW-1, in January 2010 the resin treatment was bypassed and placed in standby mode. Monitoring will continue and treatment will be restarted if necessary.
- The Middle Road treatment system continues to effectively capture VOCs using three of the six extraction wells. VOCs in the eastern segment of the plume have dropped below the 50 µg/L capture goal, and extraction wells RW-4, RW-5, and RW-6 are currently in standby mode.
- VOC contamination downgradient of the Middle Road treatment system is being hydraulically contained by the South Boundary treatment system. The four easternmost extraction wells are currently in standby mode due to VOC concentrations dropping to below the capture goal.
- The North Street and Industrial Park treatment systems continue to effectively capture VOCs in this area. Significant reductions in the off-site VOC plume concentrations have been observed.
- VOC capture goals have been achieved in one of the two North Street East System extraction wells, which has been placed in standby mode. However, groundwater monitoring is showing an area of persisting elevated VOCs that may require operating extraction well NSE-1 beyond its planned shutdown date of 2011.
- The BGRR/WCF Sr-90 treatment system captures and treats Sr-90-contaminated groundwater originating from several source areas utilizing a network of five extraction wells. Three of the extraction wells are capturing Sr-90 originating in the Building 701 area of the site from multiple sources including the BGRR below-ground ducts. In addition to the routine monitoring well sampling program, additional characterization was undertaken in 2008 and 2009 to identify the leading edge of the contaminant plume originating from the below-ground duct area and also to verify the continuing presence of high concentrations of Sr-90 at the source area. The leading edge of this plume was characterized using temporary wells. Updated groundwater modeling based on this recent data indicates that the ROD cleanup goals can still be met for the downgradient segment of this plume. Source area characterization indicates that elevated concentrations of Sr-90 are still present in the source area. The system was designed based on the source no longer being present due to capping of the area via both the BGRR building structure and an engineered cap. Monitoring of the source area will continue. It is possible that Sr-90 contamination below the facility structures in the vadose zone is being periodically released to the aquifer by water-table elevation increases. This water-table flushing process has been observed at several other BNL source areas including the HFBR and g-2. The two extraction wells located immediately downgradient of the former WCF area continue to capture and treat Sr-90. Concentrations at the source area remain elevated although

they are showing a slowly decreasing trend. An area of higher than expected Sr-90 concentrations was detected in the downgradient portion of this plume (in the vicinity of the HFBR) as part of the groundwater monitoring program in 2008. Additional characterization of this area followed by updated groundwater modeling, determined that additional extraction wells would be necessary to actively treat this area in order for the ROD cleanup goals to be achieved. Four additional extraction wells were added to the system in 2010/2011 and are expected to become operational in 2011.

- The HFBR tritium plume has significantly attenuated over the previous five years. Tritium concentrations immediately downgradient of the facility have remained largely below the MCL of 20,000 pCi/L over the past several years. The only remaining downgradient segment of the plume with concentrations exceeding the MCL is being captured by the HFBR Pump and Recharge System and is approximately 500 feet in length (see **Figure 5-2**). Concentrations in pump and recharge extraction well EW-16 have been below 2,000 pCi/L since 2009.

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.

- Post-closure groundwater monitoring continues to indicate that the OU IV air sparging/soil vapor extraction (AS/SVE) system effectively remediated the VOC-contaminated soils and groundwater.
- Monitoring continues for a plume of Sr-90 which originated at the Sump Outfall and is slowly migrating and attenuating within the central portion of the site.
- The lead-contaminated soil at the Central Steam Facility (CSF) 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, BNL developed a remediation plan for the CSF Outfall that included the excavation and disposal of all soils containing lead concentrations greater than the 400 milligrams per kilogram (mg/kg) residential use cleanup standard. Details on this remedial action plan are included in the final report titled *Remedial Investigation and Soil Remediation Evaluation and Cost Estimate for the Central Steam Facility Storm Water Outfall* (BNL 2004f). In September 2006, a contractor was hired to assist BNL in the excavation, cartage and disposal of lead-contaminated soil from the CSF Storm Water Outfall. Confirmatory sampling was performed throughout the entire project to demonstrate that lead concentrations in excavated areas satisfied the cleanup objective of 400 mg/kg. The remediation generated approximately 1,500 tons of lead-contaminated soil (60 truckloads). The last endpoint sample was collected on November 29, 2006 and analytical results indicated that cleanup objectives were met for the entire area downstream of the CSF Outfall. Details on this remedial action can be found in the *Central Steam Facility Storm Water Outfall Remediation Closeout Report* (BNL 2007c).

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. Re-vegetation of the originally 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.

- After two consecutive years of wetland vegetation monitoring, the NYSDEC determined that the Equivalency Permit conditions have been satisfied and further wetland monitoring/maintenance was not required.
- Peconic River sediment monitoring indicated that additional sediment removal was required to meet the cleanup goals for mercury. In late 2010/early 2011, approximately 800 cubic yards of contaminated sediment were excavated from three areas, the sediment trap was removed, and a draft Completion Report will be submitted to the regulators for review in the summer of 2011.

- The low-level VOC plume continues to naturally attenuate in the aquifer, and VOC concentrations in most areas have dropped to below applicable MCLs.

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 treatment system continues to effectively remediate the EDB plume. The plume continues to migrate as predicted by the groundwater model during the system design.

BGRR: The BGRR ROD was finalized in March 2005. The removal and disposal of the graphite pile was completed in 2010. The remaining work required under the ROD, including the removal of the biological shield and the installation of an engineered cap, are currently in progress. Land use and institutional controls and monitoring of groundwater in accordance with the Operable Unit III ROD are part of the final remedy. 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.

HFBR: The HFBR ROD was finalized in April 2009. The final remedy incorporates many completed interim actions, several near-term actions, and the long-term segmentation, removal, and disposal of the remaining HFBR structures, systems, and components, including the reactor vessel. The near-term actions include dismantling the remaining ancillary buildings, removing contaminated underground utilities, and preparing the reactor confinement building for safe storage. The ROD requires that these near-term actions be completed no later than 2020. Several actions have been taken since closing of the reactor in 1999 to prepare the HFBR for decommissioning. Specific activities completed for the HFBR include:

- HFBR fuel was removed and sent to an off-site facility.
- Primary coolant was drained and sent to an off-site facility.
- Scientific equipment was removed and is being reused.
- Shielding and chemicals were removed and are being reused at BNL and other facilities.
- Cooling tower superstructure was dismantled and disposed of.
- Confinement structure and spent fuel canal were modified to meet Suffolk County Article 12 requirements.
- Stack Monitoring Facility (Building 715) was dismantled and disposed of.
- Cooling Tower Basin and Pump/Switchgear House (Building 707/707A) was dismantled and disposed of.
- Water Treatment House (Building 707B) was dismantled and disposed of.
- Cold Neutron Facility (Building 751) contaminated systems were removed and the clean building has been transferred to another organization for re-use.
- Guard House (Building 753) was dismantled and disposed of.

The completion date for the near-term actions was accelerated to 2011 as a result of funding made available through the American Recovery and Reinvestment Act (ARRA). Removal of the Building 801-811 waste transfer lines (A/B waste lines with co-located piping) and contaminated soil was completed in 2009, as well as the removal of the control rod blades. Dismantling of Building 704 (Fan House), preparing the reactor confinement building for safe storage, and removal of contaminated underground utilities were completed in 2010. Dismantling of Building 802 (Fan House) is currently in progress. Planning for the demolition of the stack is also under way.

The Waste Loading Area (WLA) was part of the former HWMF, AOC 1. It is an area (of about two acres) along the eastern boundary of the former HWMF that was left in place so that it could be used as a waste staging and railcar loading area for the BGRR and HFBR decommissioning projects. The WLA was transferred to the HFBR scope of work in September 2005 through a modification to the *Remedial Design Implementation Plan* (RDIP) for the former HWMF. In February 2009, AOC 31, comprising the HFBR complex and the WLA, was established. The cleanup of the WLA was performed as a non-time-critical removal action authorized by the Action Memorandum *High Flux Beam Reactor, Removal Action for Waste Loading Area* (BNL 2007d). The cleanup of this area used the same cleanup goals and methodology required for AOC 1 in the OU I ROD. Soil remediation was performed from November 2007 to May 2008, and the cleanup goals for both chemicals and radionuclides were achieved. The maximum projected dose to an industrial worker after 50 years of institutional controls is 3.8 mRem/yr. The maximum projected dose to a resident (non-farmer) after 100 years of institutional controls is 8.9 mRem/yr. The results of the dose assessment are below the dose objective of 15 mRem/yr established by the OU I ROD and the NYSDEC *Technical and Administrative Guidance Memorandum (*TAGM) 4003 guideline of 10 mRem/yr. This work is summarized in the document *High Flux Beam Reactor, Area of Concern 31, Final Completion Report for Waste Loading Area Soil Remediation* (BNL 2009d). The WLA continues to be used for waste rail car loading.

The ROD also lays out a plan for the long-term segmentation, removal, and disposal of the remaining HFBR structures, systems, and components (including the reactor vessel and thermal and biological shields). These long-term actions will be conducted following a safe storage period (not to exceed 65 years) to allow for the natural reduction of high radiation levels to a point where conventional demolition techniques can be used to dismantle these reactor components. Land use and institutional controls and monitoring of groundwater in accordance with the Operable Unit III ROD are also part of the final remedy. 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.

Other Actions:

Soil Remediation:

In 2005, radiological contamination was identified in surface soil in several areas adjacent to the former HWMF, referred to herein as the former HWMF Perimeter Area. Since that time, several investigations have been conducted to determine the extent and nature of contamination. See *Investigation and Characterization of the Brookhaven Avenue Cs-137 Contamination* (BNL 2007e). These investigations identified radiological contamination along Brookhaven Avenue, within a contiguous area northeast of the former HWMF (approximately 18,750 ft^2) as well as several other discrete locations within wooded areas along the perimeter of the former HWMF boundaries. The contamination is believed to be a result of historical operations associated with the transfer and management of wastes to and within the former HWMF and stormwater runoff from contaminated soils within the facility. Results of the investigations revealed the following:

- Cs-137 is the primary contaminant of concern. Gamma spectroscopy results for Cs-137 ranged from not detected (ND) to 322 picoCuries per gram (pCi/g).
- Except for one area located immediately north of the roadway used to enter the former HWMF (Original Cs-137 result, 786 pCi/g), all other locations indicate that contamination is limited to the top six inches to one foot of soil.
- Most of the elevated Cs-137 results appear to be discrete soil contamination locations except for the one area immediately northeast of the former HWMF that exhibited a larger, more uniform area of contamination with Cs-137 concentrations above 23 pCi/g.
- No groundwater impacts.

The cleanup of identified radiological contamination has occurred in various stages since being discovered in October 2005. In the fall of 2008 and early winter 2009, BNL was able to address some of the easily accessible, discrete areas of contamination found along the roadway and in the woods. In late 2009, a more extensive cleanup of previously identified discrete soil contamination areas and the 18,750 ft^2 contiguous area was completed. This area was then backfilled, regraded and seeded with native grass. The cleanup of these areas, considered as Phase I of the cleanup, was documented in the April 2010 *Final Completion Report for the Former Hazardous Waste Management Facility Perimeter Area Soil Remediation* (BNL 2010a). In 2010, cleanup of an 11-acre section of the Long Island Solar Farm (LISF) Project area, located to the southeast of the former HWMF and adjacent to the previously remediated former HWMF Perimeter Area, was completed. This area is designated as Phase II and documented in the December 2010 *Addendum to the Former Hazardous Waste Management Facility Perimeter Area Completion Report* (BNL 2010b). Both Phase I and Phase II projects were remediated to meet OU I cleanup goals and were performed as non-time-critical removal actions authorized by the June 2009 Action Memorandum, *Removal of Contaminated Soil from the Former Hazardous Waste Management Facility Perimeter Area* (BNL 2009c). Remedial activities were performed in accordance with *Closeout Procedures at National Priority Sites, OSWER Directive 9320.2-09A-P*, which included:

- The excavation of contaminated soil above site cleanup goals.
- The completion of a Final Status Survey and sampling, including Oak Ridge Institute for Science and Education independent verification survey and sampling.
- The post-closure dose assessment in accordance with the Residual Radioactivity Computer Code (RESRAD).
- The characterization, transportation and disposal of excavated soil at Energy Solutions Disposal Facility of Clive, Utah.
- The implementation of institutional controls.

In December 2010, authorization for construction of the LISF Project in the 11-acre parcel of land adjacent to the former HWMF Perimeter Area was granted in accordance with an easement between the U.S. Department of Energy (DOE) and the LISF, LLC, with the control that no soil be removed from the affected area. In addition, the area was added to the *BNL Land Use Controls Management Plan,* as well as to the BNL website and BNL maps for tracking of the administrative controls. Under the easement, DOE retains responsibility for any pre-existing conditions and access to the property as needed.

Additional discrete areas of soil contamination within the former HWMF Perimeter Area that were not addressed in Phase I and II investigations will be investigated and remediated, as necessary, in future remedial efforts, referred to as Phase III. The Interagency parties will continue to be provided an opportunity to review, comment, and approve any future remedial activities proposed for this area.

Table 5-1: Actions Taken Since the 2005 Five-Year Review

Issue	Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Action Taken and Outcome	Action Completion Date
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	July 2005	Draft Plan issued to regulators; comments incorporated and Final issued	8/12/05 Draft 5/31/06 Final
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	October 2006	g-2/BLIP/UST ROD signed	5/10/07
OU I - Animal burrows in Current Landfill cap, and gates broken	Repair current burrows and fix gates	BNL	July 2005	Repaired gates and animal burrows	12/16/05 Gates 2/27/06 Burrows

Continued...

Issue	Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Action Taken and Outcome	Action Completion Date
OU I - Consistent long-term results from Wooded Wetland Monitoring	Evaluate the need to continue the annual sampling or reduce the frequency	BNL	September 2005	Evaluated in 2004. Landfill Report prepared. No changes at that time. Reduced sampling frequency to every other year per the 2008 Report.	8/12/05 2004 Rpt. 9/2/09 2008 Rpt.
Institutional controls documentation needs updating	Update *BNL Land Use Controls Management Plan* and web-based database	BNL	September 2005	Updated Plan issued in 2005, 2007, and 2009; database updated since 7/14/06	6/17/05 8/3/07 6/23/09
OU I - Consistent low VOCs in OU I extraction wells	Implement pulse pumping of treatment system to optimize performance	BNL	October 2005	Began pulse pumping (1 month on and 1 month off). Back to full-time operations in 2007. Performed additional groundwater characterization and installed monitoring wells to better assess plume.	9/6/05
OUs III & VI - Deeds not reflecting operating treatment systems	Complete survey/mapping of treatment systems off of BNL property and record updated agreements with County	BNL	June 2005	Survey/mapping completed. One agreement was recorded to date.	6/30/05 Mapping
OU III - Consistent low VOCs in Western South Boundary extraction wells	Implement pulse pumping of treatment system to optimize performance	BNL	October 2005	Began pulse pumping (1 month on and 2 months off).	9/6/05
OU III - Consistent low VOCs in Industrial Park recirculation well	Implement pulse pumping of UVB-1 to optimize performance	BNL	October 2005	Placed UVB-1 in standby mode.	10/05
OU III - Consistent low VOCs in Airport recirculation wells	Implement pulse pumping of treatment system to optimize performance	BNL	October 2005	Began pulse pumping Airport wells (1 week on and 3 weeks off).	10/3/05
Enhance monitoring well network	Implement changes to various well networks based on *2004 Groundwater Status Report*	BNL	October 2005	Implemented changes to monitoring well network each year since 2005 based on Annual Groundwater Report recommendations.	10/05

Continued...

Issue	Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Action Taken and Outcome	Action Completion Date
OU V – Restore haul roads	Per the NYSDEC equivalency permit, remove stone/fabric	BNL	September 2005	Removed stone and fabric on haul roads. Excellent vegetation recovery.	9/30/05
Housekeeping	Dispose of miscellaneous monitoring well materials at Meadow Marsh & 650 Outfall, remove Spray Aeration piping and RA V tanks	BNL	August 2005	Emptied tanks; Removed Spray Aeration piping; Disposed of well materials.	8/4/05 Tanks empty 1/11/06 Piping 8/1/07 Well Material

Table 5-1 shows the status of the actions recommended in the 2005 Five-Year Review. There are two issues that were identified in **Table 5-1** above from the 2005 Five-Year Review that affected future protectiveness. The first was to update the institutional controls documentation. The follow-up action of updating the *BNL Land Use Controls Management Plan* was completed three times starting in 2005 with the latest update in June 2009 (BNL 2005d, 2007a and 2009e). In addition, the *Land Use and Institutional Controls Mapping* database underwent a significant update since 2006, including peer reviews of the area fact sheets. The database continues to be enhanced as needed to improve its usability and effectiveness.

The second issue from the 2005 Five-Year Review was to complete surveying/mapping of the groundwater treatment systems off of BNL property and to record the license or access agreements with the Suffolk County Clerk's Office. The survey and mapping of the treatment systems was completed in June 2005 and forwarded to the property owners. All seven property license/access agreements have a requirement for recording except for LIPA, but there is a conveyance provision in that agreement. The only agreement that has been recorded to date is for the original Industrial Park system. Efforts have been and will continue to be made to record the remaining agreements with the County Clerk. It should be noted that the property for one of the access agreements changed owners in 2010 and BSA/DOE issued the executed access agreement with the new owner in March 2011.

6.0 Five-Year Review Process

6.1 Administrative Components

The activities scheduled for this Five-Year Review included regulator and community stakeholder notification, site inspections, interviews with stakeholders and regulatory officials, development of the Five-Year Review Report including review by DOE, EPA, NYSDEC, NYSDOH, 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 BSA's EPD Groundwater Protection Group. The Five-Year Review team consisted of:

- BSA staff – W. Dorsch, V. Racaniello, J. Burke, D. Paquette, R. Howe, R. Lee, S. Kumar, S. Johnson, T. Jernigan, and W. Medeiros
- DOE staff – T. Kneitel, S. Feinberg, J. Sattler, J. Carter, and G. Penny
- Regulatory staff – D. Pocze (EPA), C. Ng (NYSDEC), and A. Rapiejko (SCDHS)

The team included Hydrogeologists, Environmental Scientists, Engineers, Community Involvement Coordinators, and a Technical Editor.

6.2 Community Notification and Involvement

A Communications Plan for the Five-Year Review was prepared and on July 21, 2010, distributed to the project team including the regulatory agencies. 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* newspaper on July 22, 2010. 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/ltra/5-year_review.asp. The CAC and BER were briefed on the start of the Five-Year Review on September 9, 2010 and September 15, 2010, respectively. In addition, an announcement in the BNL weekly *Bulletin* and a BNL website 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/2010/bb072310.pdf and http://www.bnl.gov/ltra/).

Members of the CAC were polled during the September 9, 2010 meeting to obtain feedback on how informed they felt regarding the cleanup activities and progress, specific areas that the Review should focus on, and their confidence in BSA and DOE's management of the long-term cleanup at BNL. The results indicate that the CAC noted good progress with the cleanup, and the Laboratory has responded constructively to their comments. Some were interested in the potential for expediting the longer term cleanup goals (i.e., 50 and 70 years) for both soil and groundwater remediation. Others wanted the Laboratory to: continue evaluating emerging technologies; provide more focus on keeping the public informed using other media channels; request additional feedback; offer site visits/tours; and maintain funding for the long-term cleanup. Several members wanted to see a summary of how well the cleanup is going compared to the original goals. The CAC survey is included as **Attachment 1**.

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* 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

- Stony Brook University, Melville Library, Stony Brook, 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 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, BGRR, g-2/BLIP, and HFBR
- *OU III ESDs* (BNL 2005a and 2009a)
- Annual *BNL Groundwater Status Reports* (e.g., BNL 2009f)
- Annual and five-year landfill reports (e.g., BNL 2001a and BNL 2002)
- Annual Peconic River Monitoring Reports (e.g., BNL 2009g)
- *Final Five-Year Review Report* (BNL 2006a)
- Closeout/Completion reports for soil (BNL 2005c, 2005e, 2005f, 1997)
- *Final Closeout Report for the Meadow Marsh Operable Unit I Area of Concern 8* (BNL 2004d)
- *Final Closeout Report for the Ash Pit Operable Unit I Area of Concern 2F* (BNL 2004e)
- *Final Closeout Report for the Brookhaven Graphite Research Reactor, Graphite Pile Removal, Area of Concern 9 (BNL 2010c)*
- *Final Closeout Report for the Brookhaven Graphite Research Reactor, Final Canal and Deep Soil Pockets Excavation and Removal* (BNL 2005j)
- *BNL High Flux Beam Reactor Characterization Summary Report, Rev 1* (BNL 2007f)
- *Final Completion Report for the Former Hazardous Waste Management Facility Perimeter Area Soil Remediation* (BNL 2010a)
- *Addendum to the Former Hazardous Waste Management Facility Perimeter Area Completion Report* (BNL 2010b)
- *High Flux Beam Reactor, Area of Concern 31, Final Completion Report for Waste Loading Area Soil Remediation* (BNL 2009d)
- *Final Closeout Report for Removal of the Building 801-811 Waste Transfer Lines (A/B Waste Lines with Co-Located Piping) Area of Concern 31*(BNL 2010d)
- *Central Steam Facility Storm Water Outfall Remediation Closeout Report* (BNL 2007c)
- *OU IV Five-Year Review Report* (BNL 2003a)
- *Environmental Monitoring Plan,* Annual Updates (BNL 2010e)
- O&M manuals for the groundwater treatment systems (BNL 2002-2009, available at www.bnl.gov/ltra/reports.asp)
- *BNL Land Use Controls Management Plan* (BNL 2009e)
- *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 ESDs.

6.4 Data Review

This section provides a brief summary review of analytical data and trends for each OU, the HFBR, BGRR, g-2 and BLIP areas over the previous five years. Figures are provided which display historical trends for key groundwater monitoring wells by plume over the last several years. A detailed discussion of the status of the groundwater plumes and the progress of the 16 groundwater remediation systems is provided in the *2009 BNL Groundwater Status Report* (BNL 2010f—see **Attachment 2** for the CD version or http://webeims.b459.bnl.gov/gw_home/gw_home.asp). The Groundwater Status Reports are published on an annual basis and are a source of comprehensive information on the groundwater remediation systems and contaminant plumes.

Since the start of active groundwater remediation in 1997, approximately 6,433 pounds of VOCs have been removed, and over 16 billion gallons of treated groundwater have been returned to the aquifer. Additionally, the Chemical Holes Sr-90 treatment system and the BGRR/WCF treatment system have removed approximately 21 milliCuries (mCi) of Sr-90 while returning nearly 60 million gallons of treated water to the aquifer.

Figure 4-2 shows the location of the 16 groundwater treatment systems. **Table 6-1** provides a summary of the treatment system status through 2010.

Table 6-1: Groundwater Treatment System Status

Project	Target	Mode	Treatment Type	Expected System Shutdown	Highlights
OU I					
OU I South Boundary (RA V)	VOCs	Operational	P&T with AS	2015	Higher VOC concentration area of plume migrating slower than expected.
Current Landfill	VOCs tritium	Long-Term Monitoring & Maintenance	Landfill capping	NA	Groundwater continues slow improvement. VOCs and tritium stable or slightly decreasing.
Former Landfill	VOCs Sr-90 tritium	Long-Term Monitoring & Maintenance	Landfill capping	NA	No longer a continuing source of contaminants to groundwater.
Former HWMF	Sr-90	Long-Term Response Action	Monitoring	NA	Sr-90 data from 2009 characterization indicates concentrations will be below MCLs before reaching site boundary.
OU III					
Chemical/Animal Holes	Sr-90	Operational (EW-1 pulse pumping)	P&T with ion exchange (IE)	2014	System performing as expected. Began characterization of Sr-90 in western perimeter well.
Carbon Tetrachloride source control	VOCs (carbon tetrachloride)	Standby	P&T with carbon	2004 (Complete)	Petition for closure signed in 2009. System decommissioned in 2010.
Building 96 source control	VOCs	Operational	Recirculation wells with AS for 3 of 4 wells. RTW-1 is P&T with AS.	2016	System pumping and treating high concentrations of VOCs. Source area soil remediation conducted in late 2010.
South Boundary	VOCs	Operational (EW-6, EW-7, EW-8 and EW-12 on standby)	P&T with AS	2017	Continued decline in monitoring well VOC concentrations at the site boundary with the exception of one well in the vicinity of EW-4 and EW-5.
Middle Road	VOCs	Operational (RW-4, RW-5, and RW-6 on standby)	P&T with AS	2025	Extraction wells RW-1 and RW-2 continue to show moderate VOC levels. Eastern extraction wells showing low VOC concentrations. *Continued...*
OU III (Cont.)					

Project	Target	Mode	Treatment Type	Expected System Shutdown	Highlights
Western South Boundary	VOCs	Operational (Pulse)	P&T with AS	2019	Freon-12 detected during 2008 persisting in monitoring well. Additional characterization planned.
Industrial Park	VOCs	Operational (UVB-1 and UVB-2 on standby)	In-well stripping	2012	VOC concentrations continued to decline. Placed UVB-2 on standby in 2010.
Industrial Park East	VOCs	Standby	P&T with carbon	2009 (Complete)	Monitoring the remaining low VOC concentrations.
North Street	VOCs	Operational	P&T with carbon	2013	Plume concentrations continue to decrease. Began pulse pumping NS-1 in 2010.
North Street East	VOCs	Operational (Pulse)	P&T with carbon	2013	Concentrations in plume core wells at very low levels in 2010. Temporary wells installed in 2011. Operate one to two more years, then prepare petition for shutdown.
Long Island Power Authority (LIPA) Right-of-Way/ Airport	VOCs	Operational (LIPA wells EW-1L, 2L, 3L on Standby/ Airport-Pulse)	P&T and recirculation wells with carbon	2014 (LIPA) 2019 (Airport)	Airport wells continued pulse pumping in 2010. Placed LIPA well EW-2 in standby.
HFBR Tritium	Tritium	Operational	Pump and recharge	2013	Leading edge of high-concentration slug being captured by EW-16. Concentrations in source area wells remained below MCL throughout 2009. Concentration increase in 2010 due to high water table.
BGRR/WCF	Sr-90	Operational	P&T with IE	2026	Continuing source areas observed at both the WCF and BGRR (Building 701). Four new extraction wells installed in 2011 to address WCF plume.
Chemical Holes system	Sr-90	Operational (Pulse)	P&T with IE	2014	Concentrations declining since installation of pumping wells EW-2 and EW-3 in 2007.
OU IV					
OU IV AS/SVE system	VOCs	Decommis-sioned	Air sparging/ soil vapor extraction	2003 (Complete)	VOC concentrations in monitoring wells remain low. System decommissioned in Dec. 2003.
Building 650 Sump Outfall	Sr-90	Long-Term Response Action	Monitored Natural Attenuation (MNA)	NA	Plume characterized in 2010. Higher concentration area of plume ~700’ north of Brookhaven Avenue.
OU V					
STP	VOCs, tritium	Long-Term Response Action	MNA	NA	VOC plume has largely attenuated to below MCLs.

Continued...

Project	Target	Mode	Treatment Type	Expected System Shutdown	Highlights
OU VI					
Ethylene Dibromide (EDB)	EDB	Operational	P&T with carbon	2015	The EDB plume continues to migrate as predicted. The extraction wells are capturing the plume.

Notes:
AS = Air Stripping
AS/SVE = Air Sparging/Soil Vapor Extraction
EDB = ethylene dibromide
IE = Ion Exchange
LIPA = Long Island Power Authority
NA = Not Applicable
P&T = Pump and Treat
Recirculation = Double screened well with discharge of treated water back to the same well in a shallow recharge screen
In-Well = The air stripper in these wells is located in the well vault.

6.4.1 Operable Unit I

Soils: No cleanup activities were performed since 2005 for this OU. The BNL soil cleanup levels for principal radiological contaminants, based on the selected land use for each area, are provided in **Table 6-2**.

Table 6-2: 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 above background with 50 years of institutional control level.

As a follow-up to the 2005 *Closeout Report for the Former Hazardous Waste Management Facility* (Envirocon 2005), ORISE, at the request of DOE in 2007 conducted an in-process verification survey of the former HWMF. This survey was designed to identify whether the former HWMF contained any hot spots above the release criteria. The results concluded that the total dose to a future inhabitant from both the Cs-137 and Sr-90 contaminants would not increase significantly. This evaluation is documented in the report, *Data Evaluation and Dose Modeling for the Former Hazardous Waste Management Facility, Brookhaven National Laboratory, Upton, New York, Revision 1* (ORISE 2008).

The decontamination of the Merrimack Hole at the former HWMF was completed in July 2006.

Landfills: Soil-gas monitoring at the Current Landfill indicates that decomposition is still occurring. However, as with prior years, there is no indication that the vapors are migrating beyond the monitoring well network. Soil-gas monitoring at the Former Landfill Area indicates that there are only minimal detections of hydrogen sulfide, with no detectable levels of methane present. The soil-gas monitoring well networks are sufficient to monitor both landfill areas.

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 2007 indicated that risk to the adult eastern tiger salamanders from inorganic contaminants that may be in the sediment at this area was unlikely. The results of the May 2008 sediment and surface water sampling program indicate no elevated risk to adult tiger salamanders from sediments in the South or North Ponds. The average sediment concentrations for both ponds were lower than the maximum and/or background concentrations that would result in an elevated hazard quotient, as discussed in the *Final Focused Ecological Risk Assessment for OU I* (BNL 1999b). Ten years of data from both surface water and sediment sampling within the wooded wetlands indicate a stable pattern in the concentration of metals. Because of this stability, the sampling frequency of both surface waters and sediments within the wooded wetland complex was reduced to once every two years.

Groundwater: The landfill areas were capped between 1995 and 1997. Monitoring data presented in the *Environmental Monitoring Report – Current and Former Landfills* (BNL 2009h) indicate that, in general, contaminant concentrations have decreased following the capping of the landfills and landfill controls continue to be effective. Volatile organic compounds (VOCs) and metals continue to be detected downgradient of the Current Landfill. The most prevalent VOCs detected above standards are chloroethane and benzene, at maximum concentrations of 27 µg/L and 2 µg/L, respectively. **Figure 6-1** depicts VOC trends for individual wells. As with previous years, iron, manganese, and arsenic were detected downgradient from the Current Landfill at concentrations above applicable standards. Concentrations of these metals were similar to those detected in 2008. Maximum concentrations of iron, manganese, and arsenic in downgradient wells were 68,900 µg/L, 6,650 µg/L, and 23 µg/L, respectively.

VOCs were not detected above standards in Former Landfill Area monitoring wells. Leachate indicator parameters and metals concentrations were generally the same when comparing downgradient monitoring wells to upgradient monitoring wells.

Over the past five years, the OU I pump and treat system continued to maintain hydraulic control and treat 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. The overall extent and concentrations of the VOC plume have decreased significantly over the previous five years (**Figure 6-1**). The routine well network has been supplemented several times over the previous five years with temporary wells targeted to assess the remaining higher VOC concentration segment of the plume. This area extends from the site boundary to the north approximately 700 feet. Maximum total VOC concentrations range from approximately 70 to 100 µg/L. The plume has migrated to the deeper Upper Glacial aquifer in this area and is encountering the Upton Unit, which is slowing the migration rate. The Upton Unit is a lower permeability layer at the base of the Upper Glacial aquifer in this portion of the site. Existing and planned monitoring wells will provide the data needed to determine when the trailing edge of this higher concentration area has been captured and treated by the OU I system. From the start of operations in 1997 through 2009, the OU I South Boundary system has removed 353 pounds of VOCs from the aquifer.

Groundwater monitoring continues for an area of Sr-90 contamination that originated at the former HWMF and is now located approximately 2,200 feet to the south (approximately 1,000 feet north of the site boundary and OU I extraction wells). In 2010, 18 temporary wells were installed and sampled to characterize this area of Sr-90 that was initially detected in 2001. The highest Sr-90 concentration detected was 29 pCi/L, which is above the 8 pCi/L MCL but significantly lower than the peak concentration of 65 pCi/L observed in 2001. The rate of migration of Sr-90 in this area of this site is approximately 30 to 40 feet per year.

6.4.2 Operable Unit II

The remedial actions for the OU II AOCs are documented in the OU I, OU III and the g-2/BLIP/USTs RODs (see **Sections 6.4.1**, **6.4.3**, and **6.4.8**).

6.4.3 Operable Unit III

Soil: In 2008, a detailed soil characterization and soil vapor testing investigation was conducted to locate the continuing source of the Building 96 PCE groundwater plume. High PCE concentrations were identified in the unsaturated zone from just below land surface to a depth of approximately 15 feet within a surface area of approximately 25 by 25 feet. Maximum PCE concentrations detected in the soil were 1,800 milligrams per kilogram (mg/kg). A summary of the characterization data was provided in the *2008 BNL Groundwater Status Report* (BNL 2009f). A plastic liner was installed over the soil contamination area in November 2008 as a temporary measure to minimize infiltration from precipitation. To optimize the effectiveness of the Building 96 groundwater remedy, BNL recommended excavation of contaminated soils with off-site disposal. The regulatory approach for this action was to document the change in an Explanation of Significant Differences (ESD) to the OU III ROD. Following review and approval by the regulators, the *Final Operable Unit III Explanation of Significant Differences for Building 96 Remediation* (BNL 2009a) was issued. During 2010, approximately 350 cubic yards of contaminated soils were excavated and disposed of off site, and the excavation was backfilled with clean soil.

Groundwater: Over the past five years, the OU III groundwater remediation systems continued to maintain hydraulic control of contaminants originating from the central portion of the BNL site. Twelve of these systems are currently in active operation. The Carbon Tetrachloride system met the cleanup goal and was dismantled, and the Industrial Park East system is in standby mode and could be restarted if necessary. The extent of the high-concentration segments of the OU III VOC plumes have decreased as the result of active groundwater remediation and the effects of natural attenuation. Hydraulic control of the plume segments near the Middle Road, South Boundary, Industrial Park, Industrial Park East, and LIPA treatment systems can be seen on **Figure 5-1**. Complete breaks in the plumes, where contaminant concentrations have dropped below MCLs, are discernable near the South Boundary and the LIPA systems. The southernmost segment of the OU III plume has been hydraulically controlled by the Airport treatment system. As the plumes continue to decrease in size, a number of the extraction wells have been placed in either a pulse pumping mode or a standby mode (**Figure 4-3**). The HFBR Pump and Recharge system operated from May 1997 through September 2000, when it was placed in standby mode. As a ROD contingency action, the system was placed back into service in November 2007 (for details see BNL 2009f).

A review and evaluation of the performance data for the treatment systems is conducted monthly for most of the systems and quarterly for all of the systems, as well as annually for all systems. An evaluation of all the groundwater monitoring data collected for the year is documented in the annual *BNL Groundwater Status Report* (BNL 2010f).

The following is a brief status summary of OU III plume data through 2010.

Carbon Tetrachloride Treatment System

The Carbon Tetrachloride treatment system was successful in remediating the source area and resulting plume initially detected in 1998. Carbon Tetrachloride concentrations in the source area that ranged up to 179,000 μg/L in 1998 were reduced to levels below the MCL of 5 μg/L in 2009. **Figure 6-2** provides VOC trends for select monitoring wells in this plume. It began operating in October 1999, and was shut down and placed in standby mode in August 2004 after receiving regulatory approval. Groundwater monitoring continued through 2009, and a Petition for Closure of the system was submitted to the regulators in August 2009. Following the October 2009 regulatory approval for closure and decommissioning, the remediation system was removed, and the extraction wells and most monitoring wells were abandoned. While in operation from 1999 through 2004, the Carbon Tetrachloride system removed 349 pounds of VOCs from the aquifer.

Building 96 Treatment System

In 2004, VOC concentrations in three of the four Building 96 recirculation wells were below 30 µg/L total volatile organic compounds (TVOCs). As a result they were shut down and placed in standby mode in mid 2004. In addition, 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 (**Figure 6-3** for VOC trends). Hexavalent chromium was detected in area monitoring wells in 2008 as a byproduct of the potassium permanganate injections. The extent of hexavalent chromium in groundwater was fully characterized in this area and continues to be monitored as described in the *BNL Groundwater Status Reports* (BNL 2008a, 2009f and 2010f). Concentrations of hexavalent chromium in the monitoring and extraction well are currently well below the 100 µg/L New York State SPDES discharge limit for hexavalent chromium. Based upon the progress that had been made in remediating the PCE plume, in 2005, BNL prepared the *OU III Building 96 Groundwater Treatment System Shutdown Petition (AOC 26B)* (BNL 2005g). However, based upon persistent detection of high levels of PCE, the system was turned back on in 2007.

During 2008, BNL collected soil samples to determine whether there was a continuing source of PCE in the vadose zone. A localized zone of soil contamination was detected with a maximum PCE detection of 1,800 mg/kg. As a follow-up and to help identify any other potential areas of soil contamination, a soil vapor survey was conducted. No other PCE contamination areas were identified from this survey. As described earlier, in late 2010 approximately 370 cubic yards of contaminated soils were excavated and disposed of off site. PCE concentrations in source area groundwater remained as high as 3,000 µg/L during the fourth quarter of 2009. With the excavation of the contaminated soils and the continued operation of the groundwater treatment system, the cleanup goals for this area are expected to be achieved by 2016. VOC trend graphs for select wells are shown on **Figure 6-3**. From the start of operations in 2001 through 2009, the Building 96 treatment system has removed 107 pounds of VOCs from the aquifer.

Middle Road Treatment System

The Middle Road treatment system continues to effectively capture and treat VOC contamination. From 2001 through 2009, the Middle Road system has removed 862 pounds of VOCs from the aquifer. The three easternmost of the six extraction wells (RW-4, RW-5 and RW-6) are currently in standby as VOC concentrations have decreased below the system capture goal of 50 µg/L over the past several years. Total VOC concentrations remain above 50 µg/L in the westernmost three extraction wells and surrounding monitoring wells. Monitoring wells upgradient of this area have shown decreasing trends over the past five years (**Figure 6-4**). Additional groundwater characterization is planned for an area immediately to the west of these extraction wells to determine whether an area of elevated VOC concentrations migrating from the north will be captured by the Middle Road wells as that area migrates south.

South Boundary Treatment System

The South Boundary treatment system continues to capture and treat VOCs at the southern site boundary. From the start of operations in 1997 through 2009, the South Boundary system has removed 2,715 pounds of VOCs from the aquifer. TVOCs to the west have decreased to below the system capture goal of 50 µg/L. The four easternmost extraction wells have been placed in standby mode over the past five years as a result of the decreasing VOCs. The three westernmost wells continue to operate although VOC concentrations in both these extraction wells and surrounding monitoring wells have shown marked declines. Total VOC concentrations in monitoring well 121-45, which is located approximately 750 feet north of the south boundary (**Figure 6-4**), have decreased from over 600 µg/L in 2006 to 170 µg/L in the fourth quarter of

2010. This data suggests that the Middle Road system to the north has hydraulically captured the VOC plume and the remnants of the plume are attenuating as they migrate toward the site boundary. Bypass monitoring well 121-43, located approximately 700 feet south of the boundary, showed increasing concentrations of VOCs in 2009. A temporary well is planned for the south boundary to determine whether these VOCs are trapped in the stagnation zone south of the system or the contamination is migrating under extraction well EW-4.

Western South Boundary Treatment System

Plume and extraction well data show that elevated VOC concentrations continue to be observed in the western portion of the OU III South Boundary area. Extraction well WSB-2, located in the eastern portion of this area, has been pumping in a pulsed mode since 2008 due to the decreased VOC concentrations observed both in this well and area monitoring wells. Groundwater characterization efforts in 2008 revealed an area of elevated TCA approximately midway between WSB-1 and East Princeton Avenue. An area of total TVOC concentrations (consisting of primarily TCA) greater than 50 µg/L currently extends from the Middle Road south to WSB-1 (approximately 2,000 feet). A new monitoring well (119-06) was installed at the Middle Road to monitor this area in 2008. Total VOC concentrations in this well have decreased from 170 µg/L in 2008 to <5 µg/L in 2010. This area is captured and treated by WSB-1 (**Figure 6-5**). From the start of operations in 2002 through 2009, the Western South Boundary system has removed 66 pounds of VOCs from the aquifer.

During the 2008 characterization, dichlorodifluoromethane (Freon) was detected at a concentration of 60 µg/L at a depth of 192 feet below land surface in a temporary well located approximately 800 feet south of East Princeton Avenue. A permanent well was installed at this location and has been monitored since May 2009. As of the fourth quarter 2010, Freon concentrations have decreased to 23 µg/L. Additional characterization is planned in 2011 to determine the extent of this Freon contamination.

Industrial Park Treatment System

The Industrial Park treatment system is effectively capturing and treating VOCs. From the start of operations in 2004 through 2009, the Industrial Park system has removed 1,045 pounds of VOCs from the aquifer. Influent extraction well TVOC concentrations are all below the 50 µg/L capture goal, and three of the seven extraction wells are now in standby mode (UVB-1, UVB-2, and UVB-7) as shown on **Figure 4-3.** There was only one monitoring well (000-262) that was still exceeding the capture goal as of the second quarter 2010, with TVOC concentrations over 200 µg/L. The decreasing trends over the past five years in plume monitoring wells are shown on **Figure 6-6**.

Industrial Park East Treatment System

The Industrial Park East treatment system remains in standby mode following the approved Petition for Shutdown in 2009. TVOC concentrations in the two extraction wells remained below 5 µg/L in 2010 following system shutdown. Monitoring continues for an area of VOC contamination that had migrated south of the treatment system prior to startup. The highest concentration of TVOCs observed in this area during the fourth quarter 2010 was 14 µg/L in well 000-494. From the start of operations in 2004 through 2009, the Industrial Park East system removed 38 pounds of VOCs from the aquifer.

North Street Treatment System

The North Street treatment system has been highly effective in remediating an off-site area of elevated VOCs since 2004. From the start of operations in 2004 through 2009, the North Street system removed 300 pounds of VOCs from the aquifer. Total VOC concentrations in extraction well NS-1 have dropped from 600 µg/L in 2004 to less than 10 µg/L as of the fourth quarter 2010 (**Figure 6-7**). Concentrations in monitoring wells upgradient of the treatment system were all less than 75 µg/L TVOCs in 2010.

North Street East Treatment System

The off-site segment of the OU I VOC plume is captured and treated by the North Street East System. From the start of operations in 2004 through 2009, the North Street East system has removed 30 pounds of VOCs from the aquifer. The extraction wells are situated in a line along the axis of the plume. The southernmost of the two wells, NSE-2, was in a pulse pumping mode from 2006 through 2009 and was placed on standby in 2010 due to TVOC concentrations remaining below 5 µg/L in both this well and the surrounding monitoring wells. VOC concentrations in the northern segment of this plume have also decreased since the treatment system began operation in 2004 (**Figure 6-1**). All of the monitoring wells in this area and extraction well NSE-1 were below the capture goal of 50 µg/L TVOCs by the end of 2010. However, concentrations in well 000-477 showed an increase in TVOCs from 18 µg/L in 2006 to 47 µg/L in 2009. Several temporary wells were installed in 2011 to evaluate VOC concentrations upgradient of 000-477 and assess whether a petition to shut down the system could be prepared for regulatory approval. One of these temporary wells reported a TVOC detection of 70 µg/L. Based on this data, NSE-1 will be required to operate for approximately one to two additional years in order to ensure that the remainder of the plume has been captured and treated.

LIPA/Airport Treatment System

The LIPA system was designed to provide capture and control of the OU III plume that has migrated past the Industrial Park system. Groundwater from these wells is sent to a treatment facility located at the Brookhaven Airport where it is treated along with water from the Airport extraction wells. Extraction well EW-4L is capturing and treating VOCs in the upper Magothy aquifer and continues to operate. Influent total VOC concentrations were >300 µg/L in 2004 and have declined to 20 µg/L in 2011. The nearest upgradient plume core monitoring well to EW-4L is 000-130. This well displayed peak TVOC concentrations of >5,000 µg/L in 1999 and has declined to <70 µg/L in the fourth quarter 2010. The VOC contamination in the deep Upper Glacial aquifer was captured and treated by three extraction wells (EW-1L, EW-2L, and EW-3L) that are all currently in standby mode due to the reduction in VOC concentrations in these wells and in area monitoring wells to well below the 50 µg/L TVOC capture goal for this system (**Figure 6-4**).

Two segments of the OU III plumes are captured and treated at the Brookhaven Airport (located approximately 9,000 feet south of the BNL site boundary). The western segment, originating from the Building 96 and Carbon Tetrachloride source areas on site, is captured by a network of three extraction wells: RW-1, RW-2, and RW-6. Extraction well RW-6 was added to the system in 2007 in response to perimeter monitoring well detections of increasing concentrations of carbon tetrachloride. The plume had a more westward flow component than originally anticipated in this area due to hydraulic influences from the Carmans River (approximately 4,000 feet to the west). Groundwater modeling predicted that an additional well, several hundred feet west of RW-1, would be necessary to capture the leading edge of this plume. TVOC concentrations in monitoring well 800-96 (the perimeter well triggering the need for RW-6) have declined from 132 µg/L in 2007 to 50 µg/L in 2009. VOC reductions in upgradient monitoring wells indicate that the trailing edge of the high-concentration area of carbon tetrachloride is approximately 500 feet north of RW-6 (**Figure 6-4**). From the start of operations in 2004 through 2009, the LIPA/Airport system has removed 280 pounds of VOCs from the aquifer.

VOC concentrations remain low (less than 20 µg/L TVOCs) in monitoring wells in the eastern portion of the Brookhaven Airport and thus the three extraction wells are operated in a pulse pumping mode. Wells in this area are monitored to detect the arrival of VOCs that had migrated south of the North Street treatment system capture zones prior to their operation. Monitoring well 800-92, located approximately 2,000 feet north of the Airport, has been showing steadily increasing TVOC concentrations from 4 µg/L in 2005 to 216 µg/L in late 2010.

HFBR Pump and Recharge System/Plume

Considerable progress has been observed in the attenuation of the HFBR tritium plume both at the source area and at the downgradient high-concentration slug. The OU III ROD contingency of exceeding 20,000 pCi/L at Weaver Drive was triggered with a detection of 21,000 pCi/L in November 2006. In 2007, new pump and recharge well EW-16 was installed to supplement the three existing extraction wells, and the system was restarted in November 2007 as per the ROD contingency. Groundwater modeling results predict that the pump and recharge system would have to operate until approximately 2013. This prediction is reasonable based on the tritium concentrations observed during 2010. Concentrations in well EW-16 peaked at just below 3,000 pCi/L in 2008 and had declined to about 1,600 pCi/L in the fourth quarter 2010. This decline in concentrations corresponds with the characterization data for the high-concentration slug. The highest concentration observed in this downgradient area in 2010 was 19,400 pCi/L in a temporary well along the Weaver Drive transect (**Figure 6-8**). Tritium concentrations in a temporary well just north of Weaver Drive were 113,000 pCi/L in 2007. There has been a steady decline in the peak tritium concentrations detected in this slug over the past several years.

Groundwater monitoring immediately downgradient from the HFBR continued to show a decline in tritium concentrations over the past five years. Although there were no detections of tritium above the 20,000 pCi/L MCL during 2009, in the source area monitoring wells in late 2010 there was a slight increase in tritium concentrations in several wells, with concentrations ranging up to 47,500 pCi/L. It is believed that this small concentration spike is in response to an historical high water table in early 2010 and the resulting flushing effect on residual tritium in the vadose zone beneath the HFBR. The historical peak tritium concentration was over 5 million pCi/L in 1999. It appears that the remaining source of tritium is significantly depleted and that concentrations will decrease to the point that they are continually below the MCLs in the source area within the next several years. A comparison of the extent and magnitude of the HFBR tritium plume over time is presented on **Figure 5-2**.

BGRR/WCF Treatment System

There are a total of five extraction wells pumping and treating Sr-90 from two source areas. Two of the extraction wells (SR-1 and SR-2) capture and treat Sr-90 immediately downgradient of the WCF. Based on the declining Sr-90 trend in source area monitoring well 065-175 (**Figure 6-9**), it appears that the source area soil cleanup was effective in removing the groundwater contamination source. This is corroborated by the Sr-90 influent concentration decline in SR-2 from a maximum of 98 pCi/L in 1998 to 55 pCi/L in the fourth quarter 2010. Well SR-2 is located approximately 110 feet downgradient of monitoring well 065-175 (or approximately three to four years travel time).

Modeling of the groundwater characterization data from the remedial investigation (RI) and pre-design phases of the work projected that the concentrations observed in the plume downgradient of SR-1 and SR-2 would naturally attenuate to levels that would meet the OU III ESD cleanup goal for Sr-90 of MCLs by 2070. Groundwater samples collected in the southern area of this plume during the 2007/2008 g-2 tritium plume investigation revealed a slug of Sr-90 with higher than expected concentrations ranging up to 518 pCi/L. Updated groundwater modeling based on this data showed that active remediation of this area would be required to achieve the OU III ESD cleanup goals for this plume. Subsequent characterization efforts in 2009/2010 have tracked this area migrating slowly to the south (approximate rate of 20 to 40 feet per year).

The second source area for Sr-90 contamination in this area of the site is the BGRR. This source is effectively captured and treated by extraction wells SR-3, SR-4, and SR-5. Sr-90 influent concentrations in SR-3 have shown a steady decline over the past several years from a high of 1,270 pCi/L in 2007 down to 71 pCi/L during the fourth quarter 2010. A temporary well located between the BGRR and SR-3 was installed and sampled in early 2010 and showed Sr-90 concentrations as high as 592 pCi/L. It appears that high concentrations of Sr-90 continue to migrate from the BGRR source area.

In 2009, a Sr-90 concentration of 82 pCi/L was observed in plume sentinel well 075-671 (located at the leading edge of the BGRR plume near Brookhaven Avenue). Based on this detection, additional characterization work was implemented in 2009/2010 to assess whether there were higher than anticipated Sr-90 concentrations downgradient of the extraction well network. Updated groundwater modeling was performed for this plume based on the newly obtained data and it was determined that the concentrations would not jeopardize achieving the OU III ESD Cleanup Goals.

Since the start operations in 2005 through 2009, the BGRR/WCF system has removed approximately 17 mCi of Sr-90 from the aquifer.

Chemical Holes Treatment System

Sr-90 migrating south from the former source area is captured and treated by extraction well EW-1. Pulse pumping was implemented for this well in 2008 due to the stable and low influent concentrations. The pulse pumping appears to be mobilizing Sr-90 to the aquifer based on the concentration fluctuations over the past several years. Source area wells upgradient of EW-1 continue to show high Sr-90 concentrations. The peak concentration in well 106-16 (**Figure 6-10**) was 2,540 pCi/L in 1999. It decreased to 69 pCi/L in 2006 but remained above 400 pCi/L in 2010. Eight temporary wells were installed in the Chemical Holes/Animal Pits former source area in 2008 to characterize Sr-90 concentrations. The highest concentration observed was 190 pCi/L. There appears to be at least periodic mobilization of Sr-90 at the source area based on the continued high Sr-90 concentrations in source area monitoring wells such as 106-16. The mechanism for this may be the flushing of the vadose zone by rising and falling of the water table and/or precipitation flushing remnant Sr-90 from the vadose zone.

Two additional extraction wells (EW-2 and EW-3) were installed south of EW-1 in 2007 to capture and treat an area of higher Sr-90 concentrations that had migrated south of EW-1 prior to startup. This action was specifically triggered by increasing concentrations in monitoring well 106-49 which peaked at 1,530 pCi/L in 2005. This downgradient area of elevated Sr-90 was characterized in 2005/2006 using temporary wells. Updated groundwater modeling predicted that this area of contamination would not attenuate to drinking water standards by 2040 (OU III ESD Cleanup Goal) if it were not actively treated to lower concentrations. Since addition of the two extraction wells, concentrations have shown a steady decline in well 106-49 to a low of 10 pCi/L in the fourth quarter of 2010. Since the start operations in 2003 through 2009, the Chemical Holes treatment system has removed almost 4 mCi of Sr-90 from the aquifer.

6.4.4 Operable Unit IV

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

Groundwater: The OU IV AS/SVE treatment system was dismantled in 2003, and post-closure groundwater monitoring continues to show a decline in VOC concentrations. Contaminant concentrations associated with this former source area are below applicable MCLs.

Groundwater monitoring continues to evaluate the natural attenuation of an area of Sr-90 contamination which originated at the Sump Outfall and is slowly migrating to the south. Monitoring of this area began back in 1997 and the higher concentration segment was reaching the southern extent of the monitoring well network (approximately 1,200 feet southeast of the Sump Outfall) by 2010. Sr-90 concentrations for key wells are shown on **Figure 6-11**. A characterization of this area was conducted in 2010 to update data on both the nature and extent of Sr-90 concentrations. The highest Sr-90 concentration detected in temporary wells from the characterization was 74 pCi/L at a location approximately 700 feet north of Brookhaven

Avenue. Based on Sr-90 well data observations, the migration rate of Sr-90 in this area appears to be in the 20 to 40 foot per year range, which corresponds with observations for other Sr-90 plumes at the site. The newly collected data was used to perform an updated attenuation simulation using the BNL groundwater model. The model predicts concentrations will attenuate to less than the 8 pCi/L MCL by 2034. This is a conservative estimate and the maximum southward extent of the leading edge of this area (defined by 8 pCi/L) will be approximately 200 feet south of Brookhaven Avenue.

6.4.5 Operable Unit V

Peconic River: Annual data for the 2006 – 2010 Peconic River sediment, surface water, and fish monitoring program are detailed in the annual Peconic River Monitoring Reports and have been routinely reviewed with the regulators. The 2006 to 2010 mercury concentration data for sediment, surface water and fish each indicate substantial improvements relative to pre-cleanup conditions and the sediment cleanup goals or other criteria (surface water and fish concentrations). Sediment is the only matrix with a ROD-specified cleanup goal: <2.0 mg/kg mercury. The EPA's mercury criterion[1] for fresh waters is 0.3 mg/kg mercury in fish tissue residue. Although this is not a ROD-required goal, Peconic River fish tissue mercury concentrations were measured and compared to the criterion as a reference, and as a benchmark for water quality improvement.

Peconic River Sediment: Mercury data for the 30 routine Peconic River sediment sampling stations, plus one water-column sampling location (PR-WC-06) and the Sediment Trap are summarized on **Table 6-3**. Sediment was collected from PR-WC-06 to determine the source(s) of elevated water-column total mercury concentrations.

Mercury was below the cleanup goal of 2.0 mg/kg at 24 of the 30 sediment monitoring stations. However, eight of the sediment sampling stations had at least one sample with mercury concentrations greater than or equal to the cleanup goal. In addition to the annual sampling, supplemental sampling was performed at these locations. For the sediment trap and sampling stations PR-SS-15 and PR-WC-06, the frequency and magnitude of mercury concentrations greater than 2.0 mg/kg merited remedy optimization via supplemental sediment removal. Sediment excavation and off-site disposal was conducted between November 2010 and January 2011 per the *Final Plan for the Optimization of the Peconic River Remedy* (BNL 2010g). Remedy optimization locations are shown on **Figure 6-12**.

Peconic River Water Column: Mercury concentrations in the Peconic River water samples were less than or equal to 200 nanograms per liter (ng/L; equivalent to parts of mercury per trillion parts of water) with the exception of three samples collected from two locations (PR-WC-06 and PR-WC-03). One sample point (PR-WC-06) had the two highest mercury concentrations: 1,360 and 876 ng/L (**Figure 6-13**). These two water column mercury concentrations were the basis for the extensive characterization of the PR-WC-06 area (**Table 6-3)** and its subsequent sediment removal in December 2010.

Mercury data for the water-column samples are plotted on **Figure 6-13**. Each station was sampled twice per year (water depth permitting), and therefore is represented by up to 10 sample points (circles). The Connetquot River, which is sampled as a reference station, had a maximum mercury concentration of 4.52 ng/L (plotted as a reference line). The triangles represent STP effluent samples collected from about 30 feet before the effluent enters the Peconic River. As shown on **Figure 6-13**, the mercury concentrations downstream of the STP (i.e., to the right of STP-EFF-UVG) are clearly elevated relative to the stations upstream of the STP (to the left of STP-EFF-UVG). A downward trend in mercury concentration between STP-EFF-UVG and PR-WC-01 (at Schultz Road) is evident. The two lowest STP mercury samples

---

[1] Final Water Quality Criterion for the Protection of Human Health: Methylmercury, Office of Science and Technology, Office of Water, U.S. Environmental Protection Agency, Washington, DC, 20460, EPA-823-R-01-001, January 2001. All mercury within a fish is assumed to be methylmercury.

plotted[2] were collected in 2010 after routine STP maintenance consisting of the removal and replacement of the top two feet of sand in the sand filter beds was completed in 2009[3]. Additional improvements in mercury concentrations are expected following the 2010-2011 sediment removal for the PR-WC-06, PR-SS-15 and Sediment Trap areas, and the planned rerouting (to be completed in 2014) of STP effluent to groundwater rather than to the Peconic River.

Between PR-WC-01 and PR-WCS-04 (between three to five miles downstream from the STP) mercury concentrations have ranged between approximately 5 and 24 ng/L. Downstream of PR-WCS-04 mercury concentrations are generally in the range of approximately 1 to 10 ng/L, which is slightly higher than the maximum mercury concentration (4.52 ng/L) at the Connetquot River station.

Peconic River Fish: As shown on **Figure 6-14**, fish tissue mercury concentrations have decreased substantially since completion of the 2004/2005 cleanup, and additional decreases are anticipated in response to the 2010 sediment removal summarized above. The annual average fish tissue mercury concentrations from 2006 through 2010 (0.28 mg/kg) are significantly lower than the 1997 and 2001 pre-cleanup concentration (0.58 mg/kg)[4]. Also, the average mercury concentrations for the 2006 through 2010 post-cleanup fish tissue samples are lower than the EPA mercury criterion of 0.3 mg/kg.

---

[2] The STP effluent data used in this report are limited to samples collected between the times of collection of samples upstream of the STP and samples that were collected downstream of the STP. These data were collected twice annually between 2007 and 2010.

[3] In order to minimize the mass of BNL STP sewage sludge, the sludge has routinely been digested by anaerobic microbes in the sludge digester, with the liquid effluent from the digestion process being mixed with the STP influent and treated within the STP system before being discharged to the Peconic River. This and historical elevated mercury concentrations in the STP influent could have been sources for mercury that were subsequently leached from the filter bed sand into the water passing through the filter beds. The treated effluent is discharged into the Peconic River. These two potential contamination sources were removed in 2007-2009 when the sludge from the digester was removed and dried for 18 months in Geo Tubes. The sludge was then homogenized within the top two feet of sand media from filter beds 1-4 and disposed of at permitted facilities off site. Between July and September 2009 approximately 4,934 tons (approximately 3,322 cubic yards) of mixed sludge and filter bed media were removed from the beds and disposed of at Allied Landfill (96 percent) in Niagara, NY, or at Energy Solutions (4 percent) in Clive, Utah, thus removing a source of contamination to the Peconic River.

[4] The 1997 and 2001 Peconic River fish data set is shown in Table 4-10 and described on page 33 in the *Final 2009 Peconic River Monitoring Report*. The 2006-2010 fish data sets are described in each of the respective annual Peconic River Monitoring Reports.

Table 6-3. 2006 - 2010 Summary for All Routine and Supplemental Sediment Mercury Monitoring Stations

Site ID[1]	Number of Samples	Mean Mercury (mg/kg)	Minimum Mercury (mg/kg)	Maximum Mercury (mg/kg)	Standard Deviation
PR-SS-38	9	1.493	0.35	3.1	0.812
PR-SS-37	5	0.536	0.092	1	0.361
PR-SS-35	5	0.260	0.12	0.5	0.156
PR-SS-33	10	0.913	0.05	4.7	1.394
PR-SS-31	5	0.094	0.038	0.16	0.053
PR-SS-30	5	0.152	0.063	0.3	0.091
PR-SS-29	5	0.288	0.13	0.55	0.166
PR-SS-26	5	0.342	0.13	0.87	0.301
PR-SS-24	5	0.170	0.11	0.31	0.080
PR-SS-23	5	0.204	0.043	0.46	0.167
PR-SS-21	5	0.318	0.051	0.78	0.285
PR-WC-06 - Supplemental	84	2.476	0.029	22.3	4.243
PR-SS-19	41	1.116	0.13	4.4	0.958
PR-SS-18	10	0.900	0.089	4.1	1.192
PR-SS-17	5	0.537	0.027	1.2	0.501
PR-SS-16	5	1.130	0.45	1.8	0.559
Sediment Trap[2] Supplemental	25	1.14	0.057	11.1	2.366
PR-SS-15	58	4.022	0.043	36.8	8.091
PR-SS-14	5	0.270	0.16	0.41	0.090
PR-SS-12	5	0.051	0.034	0.069	0.014
PR-SS-10	37	1.487	0.052	7.1	1.568
PR-SS-09	5	0.347	0.094	0.69	0.229
PR-SS-07	5	0.058	0.016	0.091	0.030
PR-SS-06	5	0.105	0.032	0.27	0.095
PR-SS-05	5	0.300	0.059	0.85	0.327
PR-SS-04	5	0.035	0.0066	0.062	0.024
PR-SS-03	5	0.292	0.072	0.81	0.309
PR-SS-02	5	0.145	0.057	0.3	0.092
PR-SS-01	5	0.082	0.023	0.18	0.064
PR-MR-01	5	0.176	0.038	0.47	0.172
PR-MR-02	5	0.065	0.055	0.073	0.009
PR-DP-01	5	0.103	0.005	0.239	0.101

[1] Site IDs are arranged from upstream to downstream

[2] The Sediment Trap data set includes characterization samples collected 01/04/2011

Groundwater: Active treatment of the low-level VOC plume that originated from the BNL Sewage Treatment Plant (STP) was not required by the ROD. However, the groundwater continues to be monitored. VOC concentrations remained below the MCLs for individual VOCs from 2008 through 2010. This VOC plume which originated at the STP has largely attenuated. Tritium has consistently remained well below the MCL of 20,000 pCi/L. The highest tritium value reported historically from this monitoring well network was 3,320 pCi/L in 1997 from a monitoring well (050-02) located on the eastern site boundary. There have been no tritium detections above 1,000 pCi/L in monitoring wells since 2008. See **Figure 6-15** for historical VOC trends.

Select OU V and STP monitoring wells were sampled for perchlorate during 2004, prompted by the detection of perchlorate in a SCDHS monitoring well located east of BNL. 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 added routine perchlorate analyses for eight OU V wells in 2005. Based on the low levels of perchlorate detected, a recommendation was made in the *2009 BNL Groundwater Status Report* (BNL 2010f) to reduce the number of wells sampled to five and discontinue monitoring for perchlorate if levels in the wells remained below the Action Level for two consecutive years. There were no detections above the Action Level in either 2009 or 2010.

6.4.6 Operable Unit VI

Groundwater: Monitoring over the past five years continues to show a steady decline in 1,2-ethylene dibromide (EDB) concentrations as the plume migrates south and is captured and treated by the EDB treatment system. This system consists of two extraction wells (EW-1E and EW-2E). The trailing edge of the plume is approximately 1,300 feet south of the site boundary. The maximum historical detection of EDB in this plume was 7.6 µg/L in 2001 (well 000-283). During the fourth quarter 2010, the maximum EDB concentration in plume monitoring wells was 0.6 µg/L. The first detections of EDB were observed in the extraction wells in 2006 as the leading edge of the plume arrived in the area. The southward migration of the plume can be observed by comparing the EDB concentration trends for key wells on **Figure 6-16**.

6.4.7 BGRR

- Structures and Soil: Removal of the canal structure and subsurface contaminated deep soil pockets located outside the footprint of the reactor building was completed in 2005. The maximum residual Cs-137 and Sr-90 concentrations following cleanup were 5,907 pCi/g and 676 pCi/g, respectively. In most cases, any additional excavation of these areas would have resulted in a significant engineering and construction project because of shoring requirements and access limitations. Radiological surveys were completed to measure the extent of and document residual contamination. Soil samples were obtained to document the as-left conditions. The excavated areas have been backfilled, compacted and covered with a temporary asphalt cap to minimize water infiltration prior to the final cap installation currently underway. All associated waste from these actions was packaged, transported and disposed at authorized radioactive, hazardous, and clean waste disposal facilities.

  Removal and disposal of the graphite pile, control rods, boron shot, shield plugs, upper portion of air tight membrane, and the invar rods was completed in May 2010. Removal of the bioshield and installation of the final engineered cap is in progress. The completion and closeout reports document the final status of the various cleanup activities at the BGRR. For a complete list of these reports, see the reference list at the end of this report.

Groundwater: See OU III Groundwater **Section 6.4.3** for groundwater data review.

6.4.8 g-2/BLIP/USTs

Groundwater: Groundwater monitoring at the g-2 and BLIP source areas has shown that the stormwater controls have been effective in preventing additional leaching of radionuclides from the activated soil shielding. At the BLIP facility, all tritium concentrations have been less than the 20,000 pCi/L MCL since early 2006. However, tritium concentrations continue to routinely exceed 20,000 pCi/L in the g-2 source area monitoring wells. Although tritium concentrations downgradient of the g-2 source area are typically

<100,000 pCi/L, since the signing of the ROD in 2007 there have been three short-term spikes in tritium concentrations with a maximum concentration of 186,000 pCi/L during the first quarter of 2008. The periodic, short-term increases in tritium concentrations appear to be related to water-table fluctuations and the flushing of residual tritium from the deep portion of the vadose (unsaturated) zone below the source area. The overall reductions in tritium concentrations observed since 2003 suggest that the amount of residual tritium that is available to be flushed out of the deep vadose zone is decreasing.

The downgradient portion of the tritium plume (as defined by concentrations >20,000 pCi/L) is breaking up into discrete segments. Based upon the most recent sampling of the temporary wells during the first quarter 2010, the downgradient portion of the g-2 plume extends from southwest of the HFBR building to an area near the north side of the National Synchrotron Light Source, a distance of approximately 600 feet. The highest tritium concentration was 92,200 pCi/L in a temporary well installed near Temple Place. The observed tritium concentrations are consistent with model predictions of decay and dispersion effects on the plume segments with distance from the source area.

No groundwater monitoring is required for the former UST areas.

Structures and Soil: BNL has routinely inspected and maintained the caps and other stormwater controls at the g-2 and BLIP source areas. Since the signing of the ROD in 2007, only minor repairs have been required for the BLIP cap, whereas the entire g-2 cap was recoated in 2009. For the former UST areas, no additional remedial actions were required.

6.4.9 HFBR

Groundwater: See OU III Groundwater **Section 6.4.3** for groundwater data review.

Structures and Soil: The report, *BNL High Flux Beam Reactor Characterization Summary Report, Rev 1* (BNL 2007f) summarizes the historical characterizations of the facility, including the reactor itself, systems and components, ancillary support structures, and the surrounding soil. These characterizations have involved direct radiation surveys, samples for radioactivity, and calculations of activated materials over a period of several years. The data summarized in this report have helped provide the basis for many of the actions taken to prepare the HFBR for decommissioning including; dismantling ancillary buildings in the HFBR complex in 2006; the removal and disposal of the HFBR control rod blades and beam plugs in 2008 and 2009; confinement building stabilization; removal of fan house, above and below ground structures, and associated soil removal; and underground utilities, and associated soil removal. Completion and closeout reports document the final status of the various decommissioning activities at the HFBR (including BNL 2009b and 2010h). For a complete list of these reports, see the reference list at the end of this report.

Cleanup of the Waste Loading Area, and removal of Building 801-811 waste transfer lines (A/B waste lines with co-located piping) and associated soil were completed and documented in completion/closeout reports (BNL 2009d). Sampling and analysis were conducted in accordance with the dose-based cleanup goal (15 mRem/year above background with 50 years of institutional control) and methodology specified in the OU I ROD to verify that the remaining soils meet the cleanup goal. The results were presented in the completion/closeout reports. The average and maximum residual Cs-137 concentrations following cleanup were 7.4 pCi/g and 61.3 pCi/g, respectively for the Waste Loading Area. The average and maximum residual Cs-137 concentrations following cleanup for the A/B waste line soils were 0.15 pCi/g and 1.0 pCi/g, respectively.

6.4.10 Other Areas

Soils: See **Section 5.0** for a discussion of the soil characterization data and cleanup performed for the former HWMF Perimeter Areas. The average and maximum residual Cs-137 concentrations following cleanup for the Phase I perimeter soils were 4.4 pCi/g and 15.1 pCi/g, respectively. The Phase II average and maximum residual Cs-137 concentrations were 2.4 pCi/g and 16.7 pCi/g, respectively.

6.4.11 Groundwater Monitoring

The *2009 BNL Groundwater Status Report* (BNL 2010f) identifies changes to the well monitoring network at BNL (see Section 5.0 of http://www.bnl.gov/ltra/files/Annual_Reports/2009pdf/Main_Text.pdf). The changes include the installation of additional temporary and permanent monitoring wells, well abandonments, and modifications to monitoring frequency and analytical parameters.

6.5 Inspections

Representative site inspections took place between June 21 and November 18, 2010 for the landfills, soils, Peconic River, and groundwater. Representatives from BNL and DOE attended. 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. These include recommending to no longer perform inspections of the former Building 208 and Building 464 cleanup areas since they are now covered by the construction site for new buildings. It is also recommended that inspections for Recharge Basins HS and HW are no longer needed since they are already regulated under the New York State SPDES permits and any work in or near these basins are covered under the existing Work Planning and Control process, the digging permit process, and the BNL *Natural Resource Management Plan.* The completed inspection checklists are included in **Attachment 3**. All of the groundwater 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 9.0, Table 9-1**.

Monthly routine surveillances were performed on the HFBR confinement dome as part of the long-term surveillance and maintenance program for this facility from June through December 2010. Beginning in 2011 these surveillances are performed quarterly. Structural integrity, leak detection and other physical characteristics are also inspected and maintenance activities performed as specified in the surveillance and maintenance manual. No significant issues have resulted to date from these inspections.

The scope of routine surveillance activities at the BGRR includes radiological and environmental monitoring, house and grounds keeping, testing, inspection, and preventive maintenance and repair of required systems and equipment, removal of liquid and solid waste, and verification of conditions throughout the BGRR complex. Surveillance activities within the BGRR are routine in nature and are scheduled at specific frequencies based upon their intended purpose.

The caps and other stormwater controls at the g-2 and BLIP source areas are inspected two times per year, and inspection reports are submitted to the regulatory agencies annually.

6.6 Interviews

Interviews conducted in July and August 2010 consisted of discussions with the EPA, NYSDEC, 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 that BNL and DOE are actively managing the long-term cleanup operations for the site and are properly maintaining appropriate institutional controls?
- Do you have any comments, suggestions, or recommendations regarding BNL/DOE's management of the cleanup?

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

- Mr. Douglas Pocze - EPA Region 2
- Mr. Chek Ng - NYSDEC
- Mr. David O'Hehir - NYSDEC
- Mr. Andy Rapiejko- SCDHS
- Mr. Martin Trent - SCDHS
- Mr. Bill Faulk - Brookhaven Executive Round Table
- Mr. Steven Feinberg and Ms. Terri Kneitel - DOE
- Mr. Gerald Granzen - DOE
- Mr. Steve Karpinski - NYSDOH
- Mr. Ernie Lewis - BNL Envoy Program

Most people interviewed thought the cleanup has progressed well over the last five years and more recently due to the addition of American Recovery and Reinvestment Act (ARRA) funding for the reactor projects. Communication with the regulators and the community is good. The EPA Project Manager is concerned with the long-term cleanups that go out for 50 years and achieving the cleanup goals if the property is transferred or sold at some point in the future. He said there are problems with this at other federal sites. He also thought that maintaining institutional controls such as deed restrictions in the long-term will be harder if there is a transfer of property. The NYSDEC representative believes one risk in achieving the soil and groundwater cleanup goals is that something will be missed, such as a plume. However, continued monitoring will help alleviate that risk. DOE representatives felt that the cleanup is going well, and some good cost savings have been realized. Addressing all sources is important to help ensure that the ROD cleanup goals are met. NYSDOH feels the remedies are functioning as expected but they must continue to be monitored to ensure the goals will be met. Suffolk County was very positive about the progress of the cleanup. They would like to see clarified when (what years) the 50 years of institutional controls for the different soil and reactor radionuclide cleanup projects starts and ends. The interview summaries are included under **Attachment 4**.

7.0 Technical Assessment

The following subsections assess both the soil and groundwater remedies by Operable Unit and address the three EPA designated questions. Information on the majority of the soil cleanup work was completed prior to the last Five-Year Review and can be found in that document (BNL 2006a). BNL performs a comprehensive assessment of each of the groundwater treatment systems' operation, performance, plume monitoring information and opportunities for optimization as part of the annual Groundwater Status Report. The 2009 Report (*2009 BNL Groundwater Status Report* [BNL 2010f]) and reports from prior years are available for review.

The only significant institutional control issues noted over the previous five years are as follow:

- A key institutional control for the groundwater treatment systems located off of the BNL property is to ensure that the property access agreements are in place and have not been violated. To date, all requirements of the access agreements have been met, including communicating the LUICs and restrictions to the property owners. To date, the use of the properties has conformed to these controls. However, the recording of the deeds for these properties with the Suffolk County Land Registrar Office to reflect the controls and restrictions (i.e., easements) related to operation of the treatment systems is still in progress. Under a New York State provision, property easements must be taxed. The recording of the deeds have been delayed since Brookhaven Science Associates is awaiting receipt of the completed taxpayer form from the property owners.
- In 2009, site preparation work began for the Interdisciplinary Science Building (ISB). The parking lot for this new facility will be located partially on one of the Landscape Soils remediation areas adjacent to Building 355. This Area of Concern (AOC) was remediated in 2000 and a post-remediation radiological dose assessment indicated that residential cleanup levels were met. As a precaution, BNL excavated the surface soils from this previously remediated area and relocated them to the former HWMF/Waste Loading Area (WLA) during the spring of 2010. They were used to fill in low spots that collect precipitation in those areas. The EPA and NYSDEC were notified of these plans via the transmittal of a Fact Sheet and discussion on an IAG weekly conference call in November 2009.
- In 2010, DOE implemented institutional controls on the LI Solar Farm project. The institutional controls include a BNL Radiological Controls Group check on and approval prior to any soils being removed from the area; all disturbed soils remaining within the area from which they were disturbed; and adding the area to the *BNL Land Use Controls Management Plan* and LUIC Website for tracking of administrative controls.

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 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. Reconstruction activities included the planting of aquatic vegetation plants within the pond, planting of native grasses adjacent to the pond, and the addition of rip-rap 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. The 2007 ORISE verification survey concluded that the total dose to a future inhabitant from the Cs-137 and Sr-90 contaminants at the former HWMF is acceptable and meets the cleanup criteria.

- The landfill areas were capped in accordance with the ROD and the NYS Part 360 requirements. The buried waste is contained, and groundwater monitoring results indicate that the caps have achieved the objective to minimize the further leaching of contaminants from the soil into the groundwater. Although groundwater monitoring results for the Current Landfill indicate that several VOCs (e.g., chloroethane and benzene) and metals (e.g., iron and sodium) continue to be detected at concentrations above MCLs in several downgradient wells, there has been an overall reduction in VOC concentrations since the landfill was capped in 1995. Furthermore, although low levels of tritium and Sr-90 continue to be detected in the Current Landfill monitoring wells, all concentrations have been below MCLs since 1998. At the Former Landfill, there has been an overall reduction in contaminant concentrations since it was capped in 1996. Currently all VOC and radionuclide (e.g., tritium and Sr-90) concentrations are below MCLs. Iron concentrations continue to exceed MCLs in one downgradient well. The soil cover placed on the ash pit prevents direct contact with the metals in surface soils and prevents the potential migration of the metals by wind.
- The OU I groundwater pump and treat system has been in operation since 1997, and is effectively remediating groundwater contamination originating from the former HWMF and the Current Landfill. The OU I groundwater treatment system was placed in a pulsed operating mode in September 2005 because TVOC concentrations in plume core wells had dropped below 50 µg/L (the capture goal of the system). The system was placed back into full-time operations in July 2007 following the detection of elevated TVOC levels in the deep portion of the Upper Glacial aquifer (well 107-40). The system will remain in full-time operation until the remainder of the high-concentration segment of the plume is captured and treated. Model results indicate that the cleanup goals can be achieved by extending the operation of the treatment system from the planned shutdown in 2011 until 2015. This is due to the slower than anticipated migration of VOC contamination in the deep (Upton Unit) section of the Upper Glacial aquifer near the southern portion of the site.

OU I System Operations/O&M

- BNL performs monthly surveillance of the caps and associated drainage structures at the Current and Former Landfill areas. Although evidence of burrowing by small animals is common at the Current Landfill, the burrows do not penetrate beyond the outer soil layer, and therefore do not affect the protectiveness of the cap. As they are found, the burrows are filled in and repaired. Grass areas are periodically mowed, and small trees are removed before they can damage the caps. Monthly inspections will continue to ensure that the caps are properly maintained and repaired.
- The OU I treatment system operated without any significant down time or maintenance issues over the past 13 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.

OU I Costs of System Operations/O&M

The average annual O&M cost for the OU I treatment system is approximately $100K. This does not include project engineering, project management or groundwater monitoring well sampling and analysis costs.

OU I Implementation of Institutional Controls and Other Measures

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 former HWMF 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 former HWMF. 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 groundwater monitoring wells and the treatment system provides the basis to evaluate system performance and effectiveness. The monitoring wells for the OU I plume and treatment system are categorized as background, core, perimeter, or bypass wells. The landfill areas are monitored by upgradient and downgradient wells. Descriptions of the wells that are sampled and their monitoring frequencies are presented in the annual *BNL Environmental Monitoring Plan* (BNL 2010e). The monitoring data are reported in the annual *BNL Groundwater Status Report* (BNL 2010f) and the *BNL Environmental Monitoring Report – Current and Former Landfill Areas* (BNL 2009h).

OU I Early Indicators of Potential Issues

- The downgradient high-concentration VOC area is migrating slower than anticipated towards the extraction wells. Extending the operational duration of the extraction wells will ensure that this area is captured and treated. An area of Sr-90 concentrations in groundwater was initially observed and characterized in 2001 and has been monitored since that time. Updated characterization of this Sr-90 contamination in 2010 detected the current peak Sr-90 concentration of 29 pCi/L. Based on the updated data, groundwater modeling predicts that the Sr-90 will not migrate off site at concentrations greater than the 8 pCi/L MCL, that the Sr-90 will attenuate to below 8 pCi/L by 2022, and that any Sr-90 migrating beyond the site boundary would be less than the MCL. The model assumes that the OU I extraction wells will remain active until 2015, as discussed above.

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

OU I Opportunities for Optimization

- Pulse pumping was implemented for the OU I treatment system between 2005 and 2007 as VOC concentrations decreased to below the capture goal. The wells were reinstated to full-time operation in 2007 to capture the arrival of the higher VOC concentration slug migrating south. It is recommended that pulse pumping resume in order to induce a water flushing effect in the capture zone and potentially manipulate the adsorption/desorption properties of the aquifer. This may help to increase the capture of residual contaminants from the small remaining area of higher concentrations.
- Install several new monitoring wells as recommended in the *2009 BNL Groundwater Status Report* to track the Sr-90 groundwater contamination. Install one new monitoring well upgradient of the two extraction wells to help track the migration of the higher concentration VOC slug near the extraction wells.

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 items To Be Considered (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 the signing of the ROD in 1999. **Attachment 5** provides the cleanup levels for the OU I primary contaminants of concern.
- As discussed in the last Five-Year Review, the drinking water standard for arsenic changed in 2001 from 50 µg/L to 10 µg/L. Arsenic was detected above the standard in several of the monitoring wells located downgradient of the Current Landfill. However, the remedy for the Current Landfill is not affected since the arsenic levels are low. Due to the low mobility characteristics of dissolved arsenic in the aquifer, concentrations above standards are not expected to migrate any significant distance from the landfill area. During 2009, the highest arsenic level in these wells was 23.2 µg/L. Monitoring for metals, including 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.
- In 2006, a preliminary screening of the OU I groundwater VOC plume was performed to evaluate the potential for soil vapor intrusion. The Current Landfill is the only OU I area of VOC contamination that is close to an inhabited building. Although groundwater contamination immediately beneath the Current Landfill is shallow, and the levels of several VOCs exceed MCLs, the closest office building is approximately 1,000 feet upgradient of the landfill. 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. The previous Five-Year Review presented 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, landfills, or former HWMF, 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 Remedial Action Objectives

- 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. Institutional controls continue to remain effective.
- The OU I groundwater restoration project is on schedule for meeting the ROD cleanup goal of reaching MCLs for VOCs in the Upper Glacial aquifer within 30 years (by 2030). As mentioned previously, the system will continue to be operated for four years beyond its originally planned 2011 shutdown, which will then be followed by a period of monitored natural attenuation.

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.

7.2 Operable Unit II

The AOCs in this OU are documented in the OU I and OU III RODs, except for BLIP, which was documented in a separate 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 stormwater 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 remained less than the 20,000 pCi/L MCL since early 2006.
- 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* (BNL 2010e), and the results are reported to the BLIP facility operator on a routine basis and in the annual Groundwater Status Report.

The final remedy for the BLIP facility was documented in the g-2/BLIP/UST ROD which was signed in 2007.

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 MCLs.
- 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 BNL's Accelerator Safety Subject Area, if potential leachate concentrations can exceed five percent of the MCL, 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 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 are tracked and monitored via a comprehensive network of temporary and permanent monitoring wells on and off of the BNL property. Plume and system monitoring data and system performance and recommendations for optimization are described in the annual *BNL Groundwater Status Reports.*
- The groundwater remediation program remains on track to reach the overall groundwater cleanup objectives as defined by the OU III ROD and modified by the OU III ESDs. These objectives are:
    - Meet MCLs for VOCs and tritium in the Upper Glacial aquifer by 2030.
    - Meet MCLs for Sr-90 at the former Chemical Holes plume and the BGRR/WCF plumes by 2040 and 2070, respectively.
    - Meet MCLs for VOCs in the Magothy aquifer by 2065.
- Remediation of the OU III plumes began in 1997. Fourteen of BNL's 16 groundwater treatment systems are included under OU III. Twelve of these systems are currently in active operation. One system met the cleanup goal and was dismantled (Carbon Tetrachloride), one system (Industrial Park East) is in standby mode and will be restarted if needed. The HFBR Pump and Recharge system operated from May 1997 through September 2000, when it was placed in standby mode. As a ROD contingency action, the system was modified with an additional extraction well and placed back into service in November 2007 (for details see BNL 2009f). Although the Building 96 treatment system was placed in standby mode by June 2005, one well (RTW-1) was placed back into full-time service in October 2005 due to a rebound in PCE concentrations in the groundwater. In order to improve the effectiveness of the remediation efforts, BNL injected potassium

permanganate (an oxidizer) for an *in situ* treatment of a low permeability zone with high levels of PCE, modified the operations of one of the treatment wells, and excavated approximately 370 cubic yards of PCE-contaminated soil from a 25’ by 25’ by 16’ deep area.

- A detailed discussion of the progress of the OU III groundwater remediation is available in the *2009 BNL Groundwater Status Report* (BNL 2010f) (see **Attachment 2** for the CD or http://webeims.b459.bnl.gov/gw_home/gw_home.asp).
- DOE continues to offer free annual water testing to the four homeowners known to be using a private well for drinking water purposes in the OU III public water hookup area. The last time the homeowners accepted the annual test was in 2008. The test results indicate that the water quality complies with NYS drinking water standards, except for iron, which can cause taste, stain, and odor problems. Suffolk County recommended connecting to a public water supply whenever possible.
- Excavation and off-site disposal of PCE-contaminated soil at the Building 96 Source Area was completed in 2010. The designated soil cleanup levels were met. This action was taken to optimize the groundwater treatment system effectiveness. Groundwater modeling predicts that the system will have to operate from three to six additional years to achieve the VOC capture goal for the system. Also, as noted in **Section 5.0**, in January 2010 the resin treatment for well RTW-1 was bypassed and placed in standby mode due to reduced hexavalent chromium.
- The BGRR/WCF Sr-90 treatment system was modified in 2010/2011 with the addition of four new extraction wells designed to capture and treat the downgradient high-concentration slug of Sr-90 located in the vicinity of the HFBR.

OU III System Operations/O&M

The operation of each of the treatment systems is evaluated in a number of ways: monthly during preparation of the NYSDEC SPDES 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. The systems’ O&M manuals identify required preventative maintenance tasks (BNL 2002-2009). The systems are routinely inspected and can also be monitored via a remote system which allows for the control panel information to be viewed from the Groundwater Protection Group Office. 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. Maintenance of remediation 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.

The VOC treatment systems experienced mostly minor downtime or other operational issues over the past eight years, and treatment system discharges have consistently met the NYSDEC SPDES discharge equivalency permit requirements (although there have been a few minor pH excursions due to the natural groundwater conditions, and one instance of exceedance of the PCE discharge limit for the Bldg. 96 RTW-1 extraction well in June 2009, which are documented in the SPDES Discharge Monitoring Reports). A summary of issues, successes and lessons learned from the operation of the various treatment systems follows.

- The Middle Road and South Boundary treated effluent is distributed between the OU III basin and the RA V basin. This is accomplished through the use of a wet well adjacent to the air strippers and allows for the management of the amount of water that is discharged to each basin. This balancing of discharges, in combination with coordinating BNL’s management of the BNL water supply well pumpage, has been very successful in maintaining relatively steady groundwater flow directions on the BNL site and minimizing the potential shifting of plumes.
- Resin usage for the Sr-90 treatment systems has been lower than originally estimated resulting in lower operational costs. Several minor modifications to the system designs have increased their

reliability. These include removing the air stripper from the BGRR system and replacing it with carbon for treatment of low-level VOCs and bypassing the three holding tanks in both the BGRR and Chemical Holes treatment systems so that the systems operate solely utilizing the groundwater extraction pumps.

- The recirculation wells with the Industrial Park in-well air stripping system has been the most costly VOC treatment system. The technology has proven successful in removing VOC mass from the aquifer as the project is nearing its cleanup goals. However, the design of the system makes the maintenance very expensive relative to the other VOC pump and treat systems.
- The recirculation wells require more maintenance to keep them operational than conventional extraction wells and injection wells. This is due to the increased amount of equipment associated with them and the difficulties in cleaning the double screen design.
- Problems were experienced in a number of the extraction wells, with the steel drop pipes corroding and creating holes large enough to slow down or stop pumping from the wells. These have been replaced with schedule 120 PVC drop pipe or galvanized drop pipe.
- Lightning strikes in the vicinity of the treatment systems have caused numerous problems with the control systems. Systems are frequently disabled due to this issue. The programs for each system are backed up and spares of parts frequently impacted are stocked in order to mitigate this problem. This is also a sitewide problem for other BNL utilities.
- Flow meter failures have been a common problem. Both mechanical and digital meters have been used and there have been durability issues with each type. Changing some of the meters to a different manufacturer has increased durability.

OU III Costs of System Operations/O&M

- The O&M costs over the past five years for the OU III treatment systems are presented in **Table 4-1** in **Section 4.3**. The annual costs are equivalent to, if not lower than, the original estimates. The largest overall cost drivers for the systems are electricity and disposal or reuse of spent carbon and resins. It should be noted that the O&M costs in this document do not include costs for Field Engineering and Project Management or costs associated with sampling and analysis of the monitoring wells associated with each project.
- 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 can be restarted. A depiction of the current status of the individual extraction wells is provided on **Figure 4-3**.
- Due to the extensive use of activated carbon for the treatment of VOCs, a large-scale carbon services contract was awarded based on competitive bidding. The contractor performing this work contract regenerates the carbon in batches and returns the cleaned carbon back to that specific project the next time a carbon replacement is needed.
- Access agreements were negotiated with private property owners to allow the operation of treatment systems on their property. In consideration for access for the North Street East system, payments of $85K per year will be made to the property owners for as long as the treatment system is on their property. Additional payments are required for the OU VI system access agreement discussed below. Although access agreements are also in place for the other off-site treatment systems (Industrial Park, North Street East, Airport and LIPA), no lease fees are required because they are constructed on publicly owned property or along public right-of-ways.

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 LUICs continue to be maintained and are effective in protecting human health and the environment. During the past five years, there have been no activities at any of the OU III areas that would have violated these institutional controls.

The land use and institutional controls that are in place and maintained for OU III 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.
- Property access agreements for treatment systems off of BNL property are in place, and have not been violated.
- A new property access agreement relating to the North Street treatment system was executed in March 2011 due to a change in property owners.
- The treatment systems installed off of the BNL site are fenced, with locked gates, locked buildings, and video surveillance with direct feedback to BNL police. No security violations have been identified by the police.

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 are reported in the annual *BNL Groundwater Status Report.*
- Changes to the groundwater monitoring program are recommended each year in the annual *BNL Groundwater Status Report* and implemented following regulatory approval. Changes to several of the OU III plume monitoring networks were recommended in the *2009 BNL Groundwater Status Report* (BNL 2010f). These modifications, which include the installation of additional permanent monitoring wells and temporary wells, increase BNL's confidence in tracking the contaminant plumes and assessing remediation progress.

OU III Early Indicators of Potential Issues

- In 2010, approximately 370 cubic yards of PCE-contaminated soil was excavated from the Bldg. 96 area and disposed of at approved off-site facilities. With the removal of the contaminated soil and continued use of the treatment system, PCE concentrations in groundwater are expected to drop below the MCL by the approved 2030 cleanup timeframe. Based on the complete removal of PCE in the source area the groundwater model predicts that the treatment system should achieve the capture goal of 50 μg/L by 2016. There are two potential issues that could lengthen this timeframe. The first is any residual PCE that may be beneath the excavation and continues to be mobilized by the fluctuating water table. The other issue is whether there are any additional sources of PCE that have not been identified. The second issue appears unlikely due to the extensive soil-gas survey that was done in addition to the soil boring characterization of the area. Early indications based on groundwater monitoring results near the former source area are that PCE concentrations are rapidly and significantly decreasing.

- Persistent high Sr-90 concentrations in the BGRR Building 701 source area monitoring wells and extraction well SR-3 indicate the potential of a continuing source. The persistence of this source may require increased operational time for SR-3 unless the source shows signs of depleting or an engineering solution is identified to inhibit Sr-90 mobilization to groundwater.
- Persistent high concentrations of Sr-90 in the former Chemical Holes source area present a similar issue to that discussed above for the BGRR source area.
- Characterization is currently continuing to determine the extent of higher than expected VOC concentrations (approximately 600 µg/L TVOC) that are too deep to be captured by extraction well EW-4 at the southern site boundary. Characterization is also ongoing to determine the presence of higher concentration VOCs that may be located west of the capture zones of the Middle Road and South Boundary treatment systems.
- Extended operation of Western South Boundary extraction well WSB-1 is required to ensure the complete capture of a slug of TCA identified subsequent to remedy implementation. An area of elevated Freon concentrations was also indentified 4,500 feet north of the southern site boundary. Additional characterization is currently ongoing to determine its extent.
- There do not appear to be any problems or issues at this time that could place protectiveness of the remaining remedies at risk.

OU III Opportunities for Optimization

Optimization of several of the OU III groundwater treatment systems was recommended as part of the *2009 BNL Groundwater Status Report*. Several other optimization recommendations are planned for the 2010 status report. The status of each of the groundwater treatment systems is shown on **Figure 4-2** and the operational status of the extraction wells is provided on **Figure 4-3**. These changes are based on an evaluation of treatment system and monitoring well contaminant concentration trends. A summary of optimization activities and opportunities include:

- In 2010, BNL removed approximately 370 cubic yards of PCE-contaminated vadose zone soils from the former Building 96 area, thereby eliminating a continuing source of groundwater contamination. Extraction well RTW-1 was placed back into service and it is anticipated that active remediation will take another 3 to 6 years (by 2016).
- Because TVOC concentrations at the Industrial Park East system were below the 50 µg/L cleanup goal, the system was placed in standby mode in December 2009. There has been no rebound observed for VOC concentrations in the extraction or monitoring wells during 2010. BNL is working with LIPA to secure access for a sentinel monitoring well (recommended in the *2009 BNL Groundwater Status Report*) on the LIPA right-of-way.
- TVOC concentrations at the Industrial Park system area have been below the 50 µg/L cleanup goal since 2008. Extraction well UVB-2 was placed in standby mode in 2010 and three of the seven wells are now in standby mode. Only one monitoring well is currently showing concentrations above that capture goal. The system is scheduled for shutdown in 2012. In preparation for potential system shutdown, a recommendation was made in the *2009 BNL Groundwater Status Report* to install a temporary well to fill a data gap between UVB-3 and UVB-4.
- North Street East system extraction well NSE-2 was placed in pulse pumping mode in 2009 and then in standby mode in 2010 due to low VOC concentrations in the extraction well and in immediately upgradient monitoring wells. Although TVOC concentrations in NSE-1 ranged between 5 and 15 µg/L during the previous two years, the extraction well remained in operation in 2010 due to an observed VOC concentration increase in an upgradient monitoring well. This system was scheduled for shutdown in 2011; additional groundwater characterization is being performed to determine the extent of the higher VOC concentrations and whether to proceed with the petition for shutdown. A TVOC concentration of 60 µg/L was observed in one of the temporary wells installed in January 2011. Additional characterization is ongoing.

- Three of the six Middle Road treatment system extraction wells are currently in standby mode. Well RW-5 was placed back in operation in July 2009 due to a spike in VOC concentrations. This well was placed back in standby mode in 2010 following several consecutive quarterly sampling rounds showing concentrations having decreased back to levels below the 50 µg/L capture goal. TVOC concentrations have been below 2 µg/L since the third quarter of 2010. Several temporary wells were recommended as per the *2009 BNL Groundwater Status Report* to determine the location of a higher concentration slug of VOCs identified along Weaver Drive several years ago and determine whether it was in the capture zone of RW-1. A permanent well will be installed to fill a data gap adjacent to RW-1 in the deep Upper Glacial aquifer. Another will be installed approximately 500 feet north of RW-1 to provide an early indication of plume concentrations upgradient and assist in assessing when the trailing edge of the plume will be reaching the Middle Road. This work was being implemented in February 2011.
- The westernmost four of the seven South Boundary treatment system extraction wells are in standby mode due to VOC concentrations decreasing to below the 50 µg/L capture goal. A temporary well was recommended in the *2009 BNL Groundwater Status Report* just upgradient of South Boundary system well EW-4 to determine whether there may be deep contamination migrating underneath the capture zone of this well.
- Western South Boundary treatment system extraction well WSB-2 has been in pulse pumping mode since 2005 due to low VOC concentrations. WSB-1 remains in full-time operation due to a slug of high TCA concentrations currently located from the south boundary back to the Middle Road. This system was scheduled for shutdown in 2014; however, the operation of WSB-1 will be extended to 2019 to ensure the capture of the TCA slug. Characterization work is currently underway (as per a *2009 BNL Groundwater Status Report* recommendation) in 2011 to determine the extent of Freon contamination detected in the deep Upper Glacial aquifer at the Middle Road.
- The HFBR Pump and Recharge system was restarted in November 2007 as a contingency action. One additional extraction well (EW-16) was installed to facilitate the capture of the high-concentration slug. Fourth quarter 2010 characterization of the downgradient high-concentration area that triggered the contingency action resulted in all tritium concentrations remaining below the MCL of 20,000 pCi/L. Well EW-16 tritium concentrations have been steadily decreasing and below 2,000 pCi/L since August 2009. Groundwater modeling predicted that tritium concentrations would decrease to below the MCL between 2011 and 2013. It is recommended that the high-concentration area be characterized again during the third quarter of 2011 and, if concentrations in the wells remain below the MCL, place the pump and recharge wells back in standby mode and proceed with a reduced groundwater monitoring program.
- In late 2010/early 2011, BNL installed four additional extraction wells to treat high-concentration segments of the WCF Sr-90 plume located near the HFBR facility. The new wells will help reduce Sr-90 concentrations to a level required to meet the cleanup goals of less than 8 pCi/L by 2070.
- Due to the apparent continuing sources of Sr-90 contamination at both the BGRR Building 701 source and the Chemical Holes Sr-90 plume, BSA will evaluate the possibility of using techniques to stabilize the mobilization of Sr-90 in the aquifer at these locations which would allow for extraction wells at these locations to be shutdown. Pulse pumping BGRR extraction wells SR-4 and SR-5 will begin due to low influent Sr-90 concentrations over the previous two 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 5** provides the cleanup levels for the OU III primary contaminants of concern. The PCB soil cleanup levels and MCLs for groundwater have remained the same since 1999.

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.
- In 2006, two additional homes were identified, which brought the total to eight homes that continue to use their well as their sole source of drinking water. DOE continues to offer free annual water testing to the eight homeowners who continue to use their well as their sole source of drinking water.
- No new sources of contamination have been identified within OU III. However, an unanticipated byproduct of the Building 96 potassium permanganate injections was the localized creation of hexavalent chromium resulting from the interaction of the potassium permanganate and naturally occurring trivalent chromium present in the aquifer materials. It is expected that over time the hexavalent chromium will revert back to trivalent chromium. Furthermore, an ion exchange filter system was added to extraction well RTW-1 to reduce hexavalent chromium concentrations in treated water prior to discharge. Details on the characterization and monitoring of hexavalent chromium in the Building 96 area are provided in the annual *BNL Groundwater Status Reports.*
- A preliminary initial screening of the OU III groundwater VOC plume was performed in 2006 to evaluate the potential for soil vapor intrusion. There are two OU III VOC source areas where soil contamination is present and contaminated groundwater is at or close to the water table. These include the former Building 96 area where the closest occupied building is Building 452, and the former Carbon Tetrachloride UST area where the closest building is the on-site Upton service station. In the Building 96 area, a soil vapor survey was conducted in 2008 prior to the excavation of the contaminated soils, and results confirmed the high PCE concentrations only at the source area. Soil vapor PCE results were observed to drop off to low levels along the perimeters of the study area. The nearest occupied building from the plume is Building 452, Utilities Maintenance. This building is approximately 300 feet northwest of the plume and does not have a basement. The low soil-gas levels from perimeter locations indicated that additional sampling closer to Building 452 was not needed. In addition, the Building 96 source area soils were excavated in 2010. For the former Carbon Tetrachloride UST area, the UST and nearby contaminated soils were removed, and the groundwater has been remediated. Due to the proximity of the nearby carbon tetrachloride groundwater plume to Building 600 and the proposed expansion, three air samples were obtained in the basement and main level to check for this compound. The results showed that carbon tetrachloride is well below the American Conference of Governmental Industrial Hygienists (ACGIH) time-weighted average (TWA) and 8-hour threshold limit value (TLV), therefore no further action is necessary at this time.
- **Attachment 6** presents the soil vapor intrusion screenings performed in 2006 and 2008 for five buildings either under construction or recently constructed. These are the Research Support Building, the New Warehouse, the Center for Functional Nanomaterials, the National Synchrotron Light Source II, and the Interdisciplinary Science Building. A clean layer of groundwater exists above these plumes, therefore the subsurface to indoor air pathway is incomplete and no further evaluation is needed at this time.
- In the event that further construction is planned at BNL within the area of the OU III VOC groundwater plumes, BNL will re-evaluate any potential exposure issues and, if necessary, undertake appropriate measures to address them. Any construction projects to be undertaken at BNL are reviewed for environmental, security, safety and health concerns in the conceptual design or early planning phase. BNL 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 *BNL Land Use Controls Management Plan* and the LUIC groundwater

plume factsheets 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. 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 *2009 BNL Groundwater Status Report* (BNL 2010f) evaluates each system's performance based on decision rules identified from the BNL groundwater Data Quality Objective (DQO) process (see *BNL Environmental Monitoring Plan* [BNL 2010e] for discussions of the DQO process).
- As noted, 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 sources of PCE in the area. However, with the revised remedial approach of using potassium permanganate injections and the recent excavation of contaminated near surface soils, BNL believes that the objectives of reducing VOC levels in the Upper Glacial aquifer to below the MCLs by 2030 will be met. Furthermore, with the addition of two new extraction wells for the Chemical Holes Sr-90 plume in 2007, and four new extraction wells for the WCF Sr-90 plume in 2010/2011, BNL will be on track to meet the objectives of reducing Sr-90 concentrations to below MCLs by 2040 and 2070, respectively. BNL will also remain alert to any new Sr-90 remediation techniques and technologies, as well as any operational efficiency that might accomplish cleanup sooner with less waste generation.
- The property access agreements for the groundwater treatment systems off of BNL property need to be recorded with the County Clerk.
- There are no known issues with any of the institutional controls, which could jeopardize their future operation.

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

No additional information has come to light that calls into question the protectiveness of the OU III remedies. 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.

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 the Building 650 Sump Outfall in 1995. The excavation of the radiologically 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.
- BNL continues to monitor for VOCs in groundwater at select wells downgradient of the former AS/SVE system, as well as monitoring for Sr-90 at the Building 650 Sump and Sump Outfall per

the *BNL Environmental Monitoring Plan.* The results are reported in the annual *BNL Groundwater Status Report* (BNL 2010f).

- The AS/SVE-remediated area is classified for unrestricted industrial use.

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 5** 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 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

- 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 MCL, and concentrations of individual VOC compounds have decreased to levels near or below MCLs.
- The Peconic River remedy is functioning as intended:
  - The 2004/2005 Peconic River cleanup of mercury in the sediment has led to substantially reduced mercury concentrations in fish. Reduced mercury concentrations mitigate potential health impacts for human and wildlife consumers of fish.
  - Routine monitoring has functioned as intended by identifying three small areas including the sediment trap with elevated mercury concentrations in the sediment that merited removal. Cleanup of these areas was completed in late 2010/early 2011.
  - In addition to the ROD-related environmental cleanups of the BNL STP soils and the Peconic River on-site and off-site sediment, BSA/DOE have also completed remediation of the STP digester sludge and sand filter beds in 2009. Mercury concentrations in the STP effluent have been substantially lower since completion of the removal and shipment of the waste. The average of the two 2010 STP effluent Peconic River water-column monitoring program samples (72.1 ng/L) was substantially lower than the average mercury concentration for the six 2006 – 2009 samples (105.6 ng/L).
- Planned future action likely to further improve Peconic River water quality:
  - In 2014 DOE plans to start recharging the treated STP effluent directly to groundwater rather than continuing to discharge it to the Peconic River. This activity, together with the completed sludge digester and sand filter bed remediation, and the completed Peconic River sediment removal, are anticipated to even further reduce mercury concentrations in the Peconic River.

- Monitoring of the ecological receptors continues to 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 2006b).

OU V System Operations/O&M

As required by the OU V Peconic River ROD, a long-term monitoring program was implemented to ensure protection of human health and the environment. This monitoring includes mercury, PCBs and cesium-137 in sediment; total mercury and methylmercury in the water column; and mercury, PCBs and cesium-137 in fish on and off of BNL property, as appropriate. The sediment, surface water and fish monitoring results for each year since completion of the 2004/2005 cleanup (i.e., 2006-2010) are available in the annual *Peconic River Monitoring Reports* (BNL 2007g, 2008b, 2009g, 2010i, and 2011 [pending]).

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

OU V Implementation of Institutional Controls and Other Measures

Institutional controls are in place at BNL to ensure the effectiveness of all groundwater remedies. The OU V land use and institutional controls continue to be maintained and effective in protecting human health and the environment. During the past five years, there have been no activities at any of the OU V areas that would have violated these institutional controls.

The land use and institutional controls that are in place and maintained for OU V 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).

OU V Monitoring Activities

- Following completion of the Peconic River cleanup in 2005, ROD-required post-cleanup routine sediment, surface water and fish monitoring was initiated in 2006 as indicated in the *Operable Unit I Soils and Operable Unit V Long-Term Monitoring and Maintenance Plan* (BNL 2006b). The sediment, surface water and fish monitoring results for 2006-2010 are available in the annual *Peconic River Monitoring Reports* (BNL 2007g, 2008b, 2009g, 2010i and 2011 [pending]), respectively.
- Water-column samples from monitoring station PR-WC-06 had elevated mercury concentrations in 2006 and 2008. To determine the sources of the elevated mercury concentrations, BNL conducted detailed supplemental sediment sampling in 2008 and 2009 that identified sediment exceeding the

mercury cleanup goal in the PR-WC-06 area. BNL shared the data with the regulators, supplemental sediment samples verified the exceedances, and the area was then remediated in January 2011. All PR-WC-06 area confirmation samples met the ROD cleanup goals.

- In 2006, routine sediment samples from PR-SS-15 detected mercury concentrations greater than the ROD goal of 2.0 mg/kg. BNL shared the data with the regulators, supplemental samples verified the exceedances, and the area was remediated in January 2011. All PR-SS-15 area confirmation samples met the ROD cleanup goals.
- The ROD[5] required that the Sediment Trap be removed to facilitate upstream and downstream fish migration. Sediment characterization beneath and upstream of the former Sediment Trap identified mercury concentrations greater than the ROD cleanup goal. The contaminated sediment was removed and confirmation samples were collected as part of the remediation of the PR-WC-06 and PR-SS-15 areas between December 2010 and January 2011. All Sediment Trap area confirmation samples met the ROD cleanup goals.
- The remediation of both the PR-SS-15 area and the PR-WC-06 area, and removal of the Sediment Trap were completed in December 2010 and January 2011.

OU V Early Indicators of Potential Issues

- The re-growth 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. BNL met the NYSDEC Permit Equivalency requirements for invasive species control in 2007[6] and met the EPA requirements for invasive species control in 2008.
- As required by the NYSDEC Equivalency Permit, the stone and fabric from the haul access roads have been removed. However, revegetation of the former temporary haul paths will hinder access to the river for future sediment, water and fish sampling tasks. The former temporary haul path that runs along the west bank of the Peconic River between East Boundary Path in an east to southeast direction toward North Street should remain accessible to the BNL monitoring team. This will require periodic trimming of brush (approximately every three to five years) as natural re-vegetation proceeds.

OU V Opportunities for Monitoring Optimization

- The *2009 BNL Groundwater Status Report* recommended that if individual VOC concentrations in groundwater remained below MCLs during 2010, a petition would be prepared and submitted to the regulatory agencies to conclude the monitoring program. Also as per this report, sampling for perchlorate will be discontinued if there are no detections above the action level in 2011 (detections have been less than the action level since 2008).
- One year prior to this 2010 Five-Year Review, DOE recognized an opportunity to optimize the Peconic River remedy and proposed a supplemental sediment removal in two small areas: PR-WC-06 (0.217 acres) and PR-SS-15 (0.121 acres). In addition, the Sediment Trap and adjacent contaminated sediment were also removed. The supplemental sediment removal began in November 2010 and was completed in January 2011. Wetland re-planting will be completed in the summer of 2011, or as soon as river water levels allow.
- The Peconic River ROD states that after the first five years of monitoring are completed (2006 - 2010) and the data reviewed with EPA, NYSDEC and SCDHS, appropriate modifications will be made as necessary for subsequent sampling.[7] These modifications discussed below are based on the approximately 2,380 confirmation samples collected during the 2004 to 2005 20-acre cleanup,

---

[5] Page iii, last paragraph of Final Operable Unit V Record of Decision for Area of Concern 30 (Peconic River), November 3, 2004.

[6] 2007 Peconic River Monitoring Report, Attachment B.

[7] Final Operable Unit V Record of Decision for Area of Concern 30 (Peconic River), page 38, paragraph 2.

approximately 1,700 sediment, surface water and fish post-cleanup monitoring samples collected between 2006 and 2010, and the 37 sediment confirmation samples collected in December 2010 and January 2011 at the PR-WC-06, Sediment Trap, and PR-SS-15 areas. The recommendations are summarized in **Table 7-1**.

- All monitoring data has been documented in the 2006 through 2010 *Peconic River Monitoring Reports*. These data have been reviewed by and with the DOE, EPA, NYSDEC, NYSDOH, and the SCDHS. DOE recognizes that modifications to the monitoring represent additional opportunities to optimize the post-cleanup monitoring aspect of the remedy. Modifications to sediment, water column and fish monitoring are discussed below.

Table 7-1. Recommendations for Peconic River Optimization

	2011 Requirements	2012-2014	Comments
Surface Water	22 samples 2x/yr - Hg, MeHg, TSS	15 samples 2x/yr	Sample WCS-06 under S&M Program starting in 2012
	8 samples 4x/yr - water quality	Discontinue	Chlorophyll-a, N, P, TOC, TKN, TSS. Data historically provided in Appendix to Annual Peconic Report.
	4 samples 4x/yr - PR-SS-10	Discontinue	
Sediment	30 samples annually	3 samples annually	3 samples include WC-06, SS-15 and former sediment trap cleanup areas.
Fish	6 locations annually	4 locations every other year, 2013	Discontinue Manor Road and Area C in 2012
	Age determination on all fish	Age determination on all fish	
Vegetation	NYSDEC - Monitor for 2 full growing seasons for plant survival and invasive species control (4/2011 - 9/2012) EPA - 3 to 5 years for invasive species control	No change	

Sediment Monitoring Modifications

- The 2006 through 2010 sediment summary data (**Table 6-3**) indicate that 24 of the 30 routine sediment monitoring stations never exceeded the ROD cleanup goal that all mercury samples in the remediated areas would be less than 2.0 mg/kg[8]. **BSA/DOE recommend that sediment monitoring at these 24 stations is no longer necessary and can be discontinued in 2012 without jeopardizing the Peconic River risk assessment objectives** (See **Table 7-2** for those 24 stations recommended for discontinued sampling).
- **Table 7-3** summarizes the remaining six routine monitoring stations that have had at least one sediment sample exceed the 2.0 mg/kg mercury goal, and the post-cleanup data for the three areas (PR-WC-06, Sediment Trap, PR-SS-15) for which sediment was removed in 2010 and 2011. Whenever a routine sediment monitoring result equals or exceeds 2.0 mg/kg, BNL/DOE follows the data quality objectives detailed in the *Environmental Monitoring Plan*[9]. All data have been reported in the respective annual reports and reviewed with the regulators.
    - Sediment monitoring stations PR-SS-33 and PR-SS-18 each had one out of ten total samples contain greater than 2.0 mg/kg mercury. PR-SS-38 had three of nine samples

---

[8] Final Operable Unit V Record of Decision for Area of Concern 30 (Peconic River), page 28, paragraph 4.

[9] Brookhaven National Laboratory, Environmental Monitoring Plan, 2010 Update, January 1, 2010, BNL 52676-2010, page 8.2-4, third paragraph from bottom.

equal to or greater than 2.0 mg/kg., but all were less than or equal to 3.1 mg/kg. PR-SS-19 had a similar range of concentrations greater than or equal to 2.0 mg/kg and a similar mean and individual concentrations to PR-SS-18, PR-SS-33 and PR-SS-38. The average mercury concentration for each of these stations is between 0.90 and 1.49 mg/kg.

  - Review of these data with DOE, EPA, NYSDEC, NYSDOH, and the SCDHS led to agreement that no additional action would be required for PR-SS-18, PR-SS-19, PR-SS-33 and PR-SS-38 because of their low frequencies of exceeding the ROD goal and their low individual and mean mercury concentrations. **BSA/DOE recommend that future sediment monitoring at these four stations can be discontinued without jeopardizing the Peconic River risk assessment objectives** (**Table 7-3**).

- Of the remaining two routine monitoring locations (PR-SS-10 and PR-SS-15), PR-SS-10 (relative to PR-SS-18, PR-SS-19, PR-SS-33 and PR-SS-38) has one markedly elevated mercury concentration (7.1 mg/kg), the first sample collected at PR-SS-10 in 2006. Otherwise the mercury concentrations are similar to PR-SS-18, PR-SS-19, PR-SS-33, and PR-SS-38 (**Table 7-3**).
- Eleven of the 12 highest mercury concentrations in the PR-SS-10 area are less than or close to the maximum mercury concentrations at PR-SS-18, PR-SS-19, PR-SS-33, and PR-SS-38 (**Table 7-3**).
- The mean mercury concentration for all PR-SS-10 area samples was 1.49 mg/kg, which equals the mean mercury concentration for PR-SS-38.
- None of the nine additional samples collected within five feet of the original 7.1 mg/kg mercury detection at PR-SS-10 had a mercury concentration approaching the concentration of the original sample. **Figure 7-1** shows the mercury concentrations of all sediment samples collected within five feet of PR-SS-10 between 2006 and 2010. **BSA/DOE recommend that PR-SS-10 sediment monitoring be discontinued and replaced by quarterly water-column sampling for total mercury, methylmercury and total suspended solids (TSS) in 2011 to evaluate potential downstream transport of mercury and methylmercury from PR-SS-10.** These data will be shared with and reviewed with and by the regulators.
- The remaining routine sediment monitoring location at PR-SS-15, as well as supplemental sampling locations at PR-WC-06 and the Sediment Trap areas, were each remediated between December 2010 and January 2011. Post-cleanup monitoring at these three sites will consist of collecting annual sediment mercury samples at the locations of the 2006-2010 samples. For each of these three areas the respective sample locations and former maximum mercury concentrations are:
  - PR-WC-06 area (PR-WC-06-D1-L50, 22.3 mg/kg);
  - PR-SS-15 area (PR-SS-15-U1-L65-O, 36.8 mg/kg);
  - Sediment Trap area (ST1-80-U20, 11.1 mg/kg).

Table 7-2. Areas Recommended for Discontinued Mercury Sediment Sampling (Stations <2.0 mg/kg)

Site ID	Number of Samples	Mean Mercury (mg/kg)	Minimum Mercury (mg/kg)	Maximum Mercury (mg/kg)	Standard Deviation
PR-SS-37	5	0.536	0.092	1	0.361
PR-SS-35	5	0.260	0.12	0.5	0.156
PR-SS-31	5	0.094	0.038	0.16	0.053
PR-SS-30	5	0.152	0.063	0.3	0.091
PR-SS-29	5	0.288	0.13	0.55	0.166
PR-SS-26	5	0.342	0.13	0.87	0.301
PR-SS-24	5	0.170	0.11	0.31	0.080
PR-SS-23	5	0.204	0.043	0.46	0.167
PR-SS-21	5	0.318	0.051	0.78	0.285
PR-SS-17	5	0.537	0.027	1.2	0.501
PR-SS-16	5	1.130	0.45	1.8	0.559
PR-SS-14	5	0.270	0.16	0.41	0.090
PR-SS-12	5	0.051	0.034	0.069	0.014
PR-SS-09	5	0.347	0.094	0.69	0.229
PR-SS-07	5	0.058	0.016	0.091	0.030
PR-SS-06	5	0.105	0.032	0.27	0.095
PR-SS-05	5	0.300	0.059	0.85	0.327
PR-SS-04	5	0.035	0.0066	0.062	0.024
PR-SS-03	5	0.292	0.072	0.81	0.309
PR-SS-02	5	0.145	0.057	0.3	0.092
PR-SS-01	5	0.082	0.023	0.18	0.064
PR-MR-01	5	0.176	0.038	0.47	0.172
PR-MR-02	5	0.065	0.055	0.073	0.009
PR-DP-01	5	0.103	0.005	0.239	0.101

Table 7-3. Recommendations for Sediment Monitoring Stations With Mercury Concentrations > 2.0 mg/kg

Site ID	No. of Samples	No. > 2.0 mg/kg	Values > 2.0 mg/kg	Mean Mercury (mg/kg)	Minimum Mercury (mg/kg)	Maximum Mercury (mg/kg)	Standard Deviation (mg/kg)	Recommendation
PR-SS-18	10	1	4.1	0.90	0.089	4.1	1.192	Discontinue PR-SS-18 sediment sampling
PR-SS-33	10	1	4.7	0.91	0.05	4.7	1.394	Discontinue PR-SS-33 sampling
PR-SS-38	9	3	2, 2.1, 3.1	1.49	0.35	3.1	0.812	Discontinue SS-38 sampling
PR-SS-19	41	6	2, 2, 2.1 3.2, 3.4, 4.4	1.12	0.13	4.4	0.958	Discontinue PR-SS-19 sediment sampling
PR-SS-10	37	12	2, 2.1, 2.2, 2.4, 2.6, 2.7, 2.8, 3.2, 3.5, 4.3, 4.6, 7.1	1.49	0.052	7.1	1.568	Discontinue PR-SS-10 sediment sampling. Continue supplemental water column sampling in 2011 for mercury, methylmercury, TSS (four times annually).
PR-WC-06	84	21	21 samples 2.7 to 22.3	2.48	0.029	22.3	4.243	Sediment removed in 2010. Discontinue supplemental water column sampling. Collect future annual sediment samples in the PR-WC-06 area as described below.
Post-remedy Excavation PR-WC-06	19	0	Not Applicable	0.34	0.044	1.2	0.324	Initiate annual sediment mercury sampling at pre-remedy sediment removal location with previous maximum pre-cleanup sediment mercury concentration in the PR-WC-06 area (PR-WC-06-D1-L50, 22.3 mg/kg).
Sediment Trap Area	25	5	2, 2.2, 2.2, 5, 11.1	1.14	0.057	11.1	2.366	Trap and sediment removed in 2011. Collect future annual sediment samples in the PR-WC-06 area as described below.
Post-remedy Excavation Sediment Trap Area	5	0	Not Applicable	0.17	0.11	0.26	0.055	Initiate annual sediment mercury sampling at pre-remedy sediment removal station with maximum pre-cleanup mercury concentration in the sediment trap area (ST1-80-U20., 11.1 mg/kg).
PR-SS-15	58	17	17 samples 2.1 to 36.8	4.02	0.043	36.8	8.091	Sediment removed in 2011. Discontinue supplemental water column sampling. Collect future annual sediment samples as described below.
Post-remedy Excavation PR-SS-15	11	0	Not Applicable	0.13	0.029	0.67	0.191	Replace annual sediment mercury sampling at station PR-SS-15 with the sediment sampling station with the maximum mercury concentration in the PR-SS-15 area (PR-SS-15-U1-L65-O, 36.8 mg/kg).

These data will be reported in the annual *BNL Site Environmental Report* and will be evaluated with and by DOE, EPA, NYSDEC, NYSDOH, and the SCDHS. The need to continue to collect and/or to modify annual sediment samples at PR-WC-06, Sediment Trap, and PR-SS-15 will be evaluated annually with the regulators and as part of the 2015 Five-Year Review.

Surface Water Monitoring Optimization

- As shown on **Figure 6-13**, the 2006-2010 Peconic River water column total mercury concentrations are substantially higher between station STP-EFF-UVG and PR-WC-02 than at the stations located upstream and downstream of this section of the river. Future decreases in Peconic River total mercury concentrations are expected as a result of the recent remediation of the sludge digester, sand filter beds, and the PR-WC-06, Sediment Trap and PR-SS-15 areas.
- Between PR-WC-01 and PR-WCS-04 (between three to five miles downstream from the STP) the concentrations range between approximately 5 and 24 ng/L. Total mercury concentrations in the downstream section of the river between PR-WCS-04 and PR-WCS-07 are generally in the range of approximately 1 to 10 ng/L.
- **BNL recommends that routine water-column monitoring for total mercury, methylmercury and TSS continue two times per year at the 15 stations between PR-WC-15 (upstream of STP-EFF-UVG) and PR-WC-02.** This will include the anticipated reductions in surface water total mercury concentrations associated with the sediment removal and the scheduled and NYSDEC-approved initiation of discharge of the STP effluent directly to ground outside the area of recharge to the Peconic River.
- **BNL recommends that routine water-column monitoring at stations between and including PR-WC-02 and PR-WCS-07 be discontinued in 2012, with the exception of PR-WCS-06 (Donahue's Pond). PR-WCS-06 will continue to be sampled as part of the routine environmental surveillance program. BNL also recommends that analysis for water quality parameters be discontinued in 2012.** Sufficient water quality data has been collected over the previous five years to assist in the analysis of methylmercury data. These results will be published each year in the annual *Site Environmental Report.*

Fish Monitoring Optimization

Figure 6-14 shows a substantial reduction in post-cleanup (2006-2010) fish tissue mercury concentrations relative to pre-cleanup (1997 and 2001) concentrations. The figure also shows that the average mercury concentration for all fish caught between 2006 and 2010 (0.28 mg/kg) is lower than the EPA mercury criterion (0.3 mg/kg). **BNL recommends that fish monitoring be modified in the following ways:**

- Frequency will be modified from one round annually to one round every other spring. Thus, between 2011 and 2016 fish will be collected in the spring of 2011, 2013 and 2015. Harvesting fish biennially will allow the fish population to grow in both number and individual size.
- Monitoring of fish from the Manor Road area should be discontinued after the 2011 collection, due to the typically low fish catch in that area. Every two years fish monitoring would occur in Area A[10] (downstream of the STP), Area D, Schultz Road, and Donahue's Pond, when water depths are favorable. Supplemental sampling in Area C would be discontinued unless the yield was low in the two adjacent collection areas (Area A and Area D).
- Continuing fish age determination via scale and otolith interpretation through 2015.

---

[10] Note that BSA/DOE expect to initiate discharge of treated STP effluent to the water table rather than to the Peconic River, in 2014. This may cause water levels in Area A (and possibly also Area D) to be too low for fish migration except during the spring. Fish collection locations may require revision following groundwater discharge of the STP effluent.

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 5** 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.
- The plan to divert STP effluent from the Peconic River to a nearby groundwater recharge basin in 2014 will eliminate continued discharges of low levels of metals (such as mercury) to the river. The elimination of discharges to the Peconic River will cause the river bed to be completely dry from the STP outfall to the eastern firebreak road. This change in river flow may require revision of the some of the established surface water and/or fish sampling stations on the BNL site.
- 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 January 2009. To date, all test results indicate that the water quality complies with NYS drinking water standards.
- 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 radiologically 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.
- As mentioned above, BNL implemented actions since completing the Peconic River cleanup that have supplemented the progress achieved as a direct result of the ROD-required Peconic River cleanup:
    - The removal of historical sludge from the sludge digester, mixing it with sand from the four active sand filter beds, and disposing the sand/sludge mixture at permitted off-site disposal facilities.
    - Current plans are to discontinue discharging the treated effluent into the river. BSA anticipates completing this project in 2014. This will discontinue the historical source of the majority of Peconic River contaminants and is expected to further support the protection of ROD cleanup goals and risk assessment objectives.
- Supplemental sediment removal of locations in the Peconic River was completed in January 2011 for the two small areas identified above and the sediment trap. Post-cleanup sediment monitoring is expected to demonstrate compliance with the Peconic River cleanup goals and risk assessment objectives identified in the Peconic River ROD.
- 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 nor 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 is currently positioned entirely south of the BNL site.
- The EDB groundwater treatment system was installed in accordance with the OU VI ROD, and began operating in August 2004. EDB is being captured by the extraction wells and the hydraulic capture performance of the system is being met as described in the Startup Report. The detection of EDB in the influent samples from the groundwater extraction wells for the past several years indicates that the plume is being captured by the extraction wells. An additional well is being added to increase monitoring of the eastern perimeter of the plume just north of the extraction wells as per the recommendation in the *2009 Groundwater Status Report*. The system is currently on schedule to meet the cleanup goal of reaching the MCL by 2030.
- 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. Two of the homeowners had their wells last sampled in 2009 and 2010. The results for all samples have showed compliance with the NYS drinking water standards. The remaining home is currently vacant.

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.

OU VI Costs of System Operations/O&M

- The system has been operational for five years and the average annual O&M cost is approximately \$190K. 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, total payments of \$85K per year are 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. 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 *BNL Groundwater Status Report*.
- Changes to the OU VI plume monitoring network are recommended in the annual *BNL 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

An additional groundwater monitoring well is planned to enhance monitoring of the eastern edge of the plume to the north of the extraction wells. There are no other opportunities identified at this time.

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 5** provides the cleanup levels for the OU VI primary contaminants of concern. In December 2009, the SPDES equivalency permit level for EDB was changed by the NYSDEC from 5.0 µg/L to 0.03 µg/L to reflect an updated practical quantification limit based on EPA Method 504.1. The MCL for EDB is 0.05 µg/L. There have been no detections of EDB in the system effluent above SPDES Equivalency permit levels since the system began operations in 2004.

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 two homeowners in the OU VI plume area who are still using their private wells for drinking purposes. These homeowners had their wells last sampled in 2009 and 2010. The results for all samples were below the NYS 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, 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 Triennial Update* [BNL 2003c] for the DQO process). As described in the *2004 BNL Groundwater Status Report* (BNL 2005h), EDB concentrations are expected to be lowered to below the 0.05 µg/L MCL by 2030, as required by the OU VI ROD.
- The two property access agreements for the groundwater treatment system need to be recorded with the County Clerk.

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 nor 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 Memoranda and NEPA categorical exclusions 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 (i.e., limiting worker exposure), and implementing monitoring, maintenance, and institutional controls to manage potential hazards. Specific activities completed to help reduce the radiological inventory, to reduce the potential for exposure, and to prevent the future migration of radiological contamination into surrounding soil and groundwater 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
    - 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.
    - Removal of the exhaust cooling coils and filters
    - Removal of BGD primary liner
    - Sealing of the BGDs
- 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 (BNL 2005i) and is consistent with the selected remedy in the BGRR ROD. A completion report was prepared and issued to the regulators in 2005.
- A temporary asphalt cap was installed over the soil areas in 2005 to minimize water infiltration prior to the final cap installation.
- Removal of the graphite pile in accordance with the ROD was completed in May 2010. A final closeout report was issued to the regulators in October 2010.

- The remaining work to be performed, including removal of the biological shield and installation of the final engineered cap for water infiltration management, is currently being implemented in accordance with the ROD Remedial Design/RA Work Plan.

BGRR System Operations/O&M

As required by the BGRR ROD, long-term S&M activities are conducted to ensure effectiveness of the remedy. Specific measures are being implemented for the BGRR project. They include the following:

- Routine environmental health and safety monitoring.
- Radiation detection monitoring.
- Secure access via locked doors.
- 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 S&M activities is approximately $450K annually (in FY10 dollars) for routine surveillance and groundwater monitoring. Additionally requirements include $12K every 10 years for infiltration barrier upkeep and $760K every 20 years to refurbish the Building 701 exterior facade and roof system. The S&M activities include radiation and environmental monitoring, the testing, inspection, and maintenance/repair of essential equipment, and verification of conditions throughout the facilities. Activities also include preventative and corrective maintenance on the temporary asphalt cap to ensure its integrity.

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 are being implemented:

- Control measures for future excavation of residual subsurface contamination – No digging, drilling, ground-disturbing activities, or groundwater shall be extracted within the area designated on 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. 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.
- 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. Work is planned to limit 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

- Robotic tools and remote handling technologies have been employed to implement the remedy while minimizing radiation exposure to the workers.
- For the graphite pile removal, a remote manipulator fitted with special tools was installed on top of the biological shield. It was used to remove the graphite blocks from the pile and load them into soft-sided containers called “supersacks.” They were then placed inside metal containers for shipment to DOE’s Nevada Test Site for disposal. All graphite handling took place inside a contamination control enclosure that was maintained at a slight negative pressure (with respect to the atmosphere) in order to eliminate the release of radioactive material to the environment.
- For biological shield removal that is currently in progress, remote-operated tools operating inside a contamination control enclosure are being used.

BGRR Early Indicators of Potential Issues

- A potential continuing source of Sr-90 contamination beneath the BGRR below ground ducts is a concern for the groundwater remediation system. See **Section 7.3** for additional discussion.
- Continued protection of workers during the remaining bioshield removal is an important consideration.

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.

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 nor 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 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 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 structure and the soon-to-be-installed engineered cap 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 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. Continued evaluation of the potential continuing source of Sr-90 contamination from the BGRR below ground ducts will be performed.

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 g-2/BLIP/USTs

g-2/BLIP/USTs Question A: Is the remedy functioning as intended by the decision documents?

g-2/BLIP/USTs Remedial Action Performance

- Groundwater monitoring at the g-2 and BLIP source areas has shown that the stormwater controls have been effective in preventing additional leaching of radionuclides from the activated soil shielding. At the BLIP facility, all tritium concentrations have been less than the 20,000 pCi/L MCL since early 2006. However, tritium concentrations continue to routinely exceed 20,000 pCi/L in the g-2 source area monitoring wells. During 2009, a maximum concentration of 138,000 pCi/L was detected during the fourth quarter sampling round. As in past years, periodic, short-term increases in tritium concentrations appear to be related to water-table fluctuations and the flushing of residual tritium from the deep portion of the vadose (unsaturated) zone below the source area. The overall reductions in tritium concentrations observed since 2003 suggest that the amount of residual tritium that is available to be flushed out of the deep vadose zone is decreasing.

- The downgradient portion of the tritium plume (as defined by concentrations >20,000 pCi/L) is breaking up into discrete segments. Based upon the most recent sampling of the aquifer using temporary wells, the downgradient portion of the g-2 plume extends from southwest of the HFBR building to an area near the north side of the National Synchrotron Light Source, a distance of approximately 600 feet. The highest tritium concentration was 92,200 pCi/L in a temporary well installed near Temple Place road. The observed tritium concentrations are consistent with model predictions of decay and dispersion effects on the plume segments with distance from the source area.
- No groundwater monitoring is required for the former UST areas.

g-2/BLIP/USTs System Operations/O&M

As required by the 2007 ROD, long-term cap maintenance activities are 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 the g-2/BLIP/USTs ROD and other approved RODs. To accomplish this objective, specific measures are being implemented for the g-2/BLIP project. They include the following:

- Routine inspections and maintenance of the caps and other stormwater controls at the g-2 source area and BLIP facility.
- Groundwater monitoring required to verify that the source controls are in effect and to monitor the attenuation of the g-2 tritium plume.
- There are no actions associated with the former UST areas.

g-2/BLIP/USTs Costs of System Operations/O&M

The estimated annual costs for routine surveillance and groundwater monitoring are:

- Approximately $5,000 for routine inspections and maintenance of the caps and other stormwater controls at the g-2 source area and BLIP facility. However, in 2009 the g-2 cap was entirely resurfaced at a cost of approximately $50,000.
- Approximately $30,000 for monitoring the g-2 source area; approximately $20,000-$30,000 for the installation and sampling of temporary wells used to monitor the downgradient portion of the g-2 tritium plume; and approximately $5,000 for monitoring groundwater at the BLIP facility.
- There are no costs associated with the former UST areas.

g-2/BLIP/USTs Implementation of Land Use and Institutional Controls and Other Measures

- The *BNL Land Use Controls Management Plan* (LUCMP, BNL 2005d) provides an overview of land use and other controls that are deployed at BNL to prevent exposure to residual environmental contamination. The web-based *Land Use and Institutional Controls Mapping* tool contains map locations and fact sheets for the g-2 and BLIP facilities. The LUCMP is a living document and is periodically updated to stay current with evolving management techniques.
- There are no LUCMP issues associated with the former USTs.

g-2/BLIP/USTs Monitoring Activities

- Groundwater monitoring at the g-2 and BLIP source areas will continue throughout the institutional control period. Results of the g-2 and BLIP monitoring programs will be used to help verify the effectiveness of the remedy.
- Groundwater monitoring of the downgradient portion of the tritium plume will continue until the tritium concentrations decrease to below the 20,000 pCi/L MCL.
- No groundwater monitoring is required for the former UST areas.

g-2/BLIP/USTs Opportunities for Optimization

There are no opportunities for optimization identified at this time. Monitoring data indicate that the source area controls are effective and the g-2 tritium plume is attenuating in the aquifer as anticipated.

g-2/BLIP/USTs Early Indicators of Potential Issues

- There have been no changes in the physical conditions at the g-2 or BLIP facilities or in the use of the site that would reduce the protectiveness of the remedies nor render the initial risk analysis invalid. Also, the exposure assumptions have not changed since the ROD was signed in 2007.
- Contamination levels in the soil shielding at the g-2 and BLIP source areas should be consistent with those evaluated at the time of the 2007 ROD, and monitoring data suggest that the caps and other stormwater controls are effective. Because the g-2 facility has not operated since the completion of the project in April 2001, no additional buildup of radioactivity has occurred. Although the BLIP is an active facility, additional buildup of radioactivity is occurring in a zone of soil shielding that was injected with colloidal silica grout in 2002, which, in addition to the cap, offers additional protection from potential stormwater infiltration into the activated shielding.

g-2/BLIP/USTs Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?

g-2/BLIP/USTs Changes in Standards and TBCs

The standards or TBCs identified in the ROD have not changed nor do they call into question the protectiveness of the remedy.

g-2/BLIP/USTs Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics, and Risk Assessment Methods

There have been no changes in the physical conditions within the g-2 or BLIP facilities or use of the site that would reduce the protectiveness of the remedies nor render the initial risk analysis invalid. Also, the exposure assumptions have not changed since the ROD was signed in 2007. There are no risks associated with the former UST areas.

g-2/BLIP/USTs Expected Progress in Meeting RAOs

- Groundwater monitoring at the g-2 and BLIP source areas has shown that the stormwater controls have been effective in preventing additional leaching of radionuclides from the activated soil shielding. At the BLIP facility, all tritium concentrations in groundwater have been less than the 20,000 pCi/L MCL since early 2006. However, tritium concentrations continue to routinely exceed 20,000 pCi/L in the g-2 source area groundwater monitoring wells. The continued detection of tritium appears to be related to water-table fluctuations and the flushing of residual tritium from the deep portion of the vadose (unsaturated) zone below the source area. The overall reductions in tritium concentrations observed in the g-2 source area wells since 2003 suggest that the amount of residual tritium that is available to be flushed out of the deep vadose zone is decreasing by means of this flushing mechanism and natural radioactive decay.
- The downgradient portion of the tritium plume (as defined by concentrations >20,000 pCi/L) is breaking up into discrete segments. The currently observed tritium concentrations are consistent with model predictions of decay and dispersion effects on the plume segments with distance from the source area.
- There are no continued environmental concerns associated with the former UST areas.

g-2/BLIP/USTs 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 at the g-2 or BLIP facilities, nor have there been any changes in land use. There are no continued environmental concerns associated with the former UST areas. No additional information has come to light that calls into question the protectiveness of the remedy defined in the ROD.

7.9 HFBR

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

HFBR 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 Memoranda (BNL 2007d and 2008c) and *National Environmental Policy Act* (NEPA) categorical exclusions, and are consistent with the HFBR ROD. This has achieved the remedial action objectives of: protecting human health from the hazards posed by the radiological inventory at the HFBR, using the ALARA principle, and implementing monitoring, maintenance, and institutional controls to manage potential hazards.

HFBR System Operations/O&M

Long-term S&M activities are being conducted in accordance with the *Long-Term Surveillance and Maintenance Plan for the HFBR (BNL 2011*) 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 the HFBR ROD and other approved RODs. To accomplish this objective, specific measures are being implemented for the HFBR project. They include the following:

- Routine environmental health and safety monitoring.
- Secure access via locked doors.
- Periodic structural inspections of Building 750.
- Water intrusion monitoring.
- Preventive maintenance of Building 750 and the infiltration management system.
- Groundwater monitoring required as part of the OU III ROD.

HFBR Costs of System Operations/O&M

The estimated cost of S&M activities required to ensure that Building 750 (HFBR) remains in a safe and stable condition during the safe storage phase is approximately $200K annually (in FY10 dollars). The S&M activities include radiation and environmental monitoring, the testing, inspection, and maintenance/repair of essential equipment, and verification of conditions throughout the facilities.

HFBR Implementation of Land Use and Institutional Controls and Other Measures

The HFBR remedy includes the continued implementation of LUICs in accordance with the LUCMP. These include:

- Measures for controlling future excavation and other actions that could otherwise disturb residual subsurface contamination.
- Land use restrictions and an acceptable method for evaluating potential impact that the remaining contaminants have on future development.
- Periodic certification to EPA and NYSDEC stating that the institutional 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 or constitute a violation or failure to comply with the site management plan. This annual certification will be prepared and submitted by a professional engineer or environmental professional acceptable to NYSDEC.

DOE is currently responsible for implementing the land use controls with regard to the property that is the subject of the HFBR ROD. If the property is transferred out of federal ownership, it is DOE's intention that all continuing land use restrictions, reporting requirements, and any other obligations relating to the property of DOE (or any other successor federal entity on behalf of the United States) will be satisfied through the United States' conveyance of a deed restriction/ environmental easement prior to any such transfer of any deed(s) to the property.

While it is DOE's intention that any such deed restriction/environmental easement would require that the transferee (and subsequent transferees) would be required to satisfy all of DOE's obligations relating to the property, DOE acknowledges that, notwithstanding this intention, it (or any other successor federal entity on behalf of the United States) remains ultimately responsible for satisfying DOE’s remedial obligations set forth in this ROD relating to the property if any subsequent transferee fails to satisfy the remedial obligations in this regard.

Any activity that is inconsistent with the land use restrictions or actions that may interfere with the effectiveness of the institutional controls established for the HFBR complex will be addressed by DOE with EPA and NYSDEC, as outlined in the BNL LUCMP. LUICs will be maintained until the hazardous substances reach levels that allow unlimited use and unrestricted exposure.

HFBR Monitoring Activities

The *Long-Term Surveillance and Maintenance (S&M) Plan for the HFBR* was developed to manage the inventory of radioisotopes that will remain in the HFBR Confinement Building during the safe storage (decay) period and subsequent decontamination and dismantlement. The details of the S&M processes are contained in a supporting document – the *Long-Term S&M Manual*. The S&M Plan and Manual will be implemented to ensure that the inventory of stored radioisotopes and all residual contamination is maintained in a safe condition, and to preclude future human exposure pathways or migration from their locations within the HFBR.

HFBR Opportunities for Optimization

There are no apparent opportunities for optimization at this time

HFBR Early Indicators of Potential Issues

Continued protection of workers during the remaining activities (demolition of Building 802 and stack) is an important consideration. Controls developed and implemented for the completed remedial actions (demolition of Building 704 and removal of underground utilities) will be used to help mitigate potential risk.

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

HFBR Changes in Standards and TBCs

The standards or TBCs, including DOE Orders, identified in the HFBR ROD have not changed nor do they call into question the protectiveness of the remedy.

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

- There have been no changes in the physical conditions within the HFBR complex or in the use of the site that would reduce the protectiveness of the remedies nor render the initial risk analysis invalid. Also, the exposure assumptions have not changed since the ROD was finalized in 2009.
- No new contaminants or sources of contamination have been identified within the HFBR, and no unanticipated toxic byproducts have been detected.
- In accordance with the HFBR ROD, DOE will determine the feasibility of reducing the 65-year safe storage (decay) period and completing the removal of large activated components earlier taking into consideration the following factors:
    - Advancements in cleanup technologies and transportation methods.

  - Availability of waste disposal facilities.
  - Changes in standards and regulations for worker, public, and environmental protection.
  - Worker safety impacts.
  - Environmental impacts.
  - Public health impacts.
  - Economic impacts.
  - Land use.
  - Existing stabilization and safety of the facility and hazardous materials.
  - Projected future stability and safety of the facility and hazardous materials.
- No advances in new technologies or other factors have been identified since the ROD was finalized in 2009 that would warrant a reduction in the 65-year safe storage (decay) period.
- Recognizing that there are uncertainties inherent in activation analyses, per the ROD, DOE conducted an additional investigation involving the following steps:
  - Performed radiation surveys (measurements of radiation levels) after the removal of the control rod blades from the reactor vessel. (Surveys before the removal of control rod blades with high dose rates would not yield reliable results).
  - Reevaluated the dose rate at 1 foot from the large activated components (reactor vessel, thermal shield, and biological shield) based on the radiation surveys.
  - Using the reevaluated dose rates, determined the decay period necessary for the dose rate at 1 foot to fall below 100 mRem/hour for the large activated components, including the limiting component.
  - Used the results of the additional investigation in this Five-Year Review in assessing the feasibility of shortening the decay period.
- The following conclusions from this evaluation were reached:
  - The predicted time for when the large limiting activated component (i.e., thermal shield) will decay to 100 mRem/hour is in 65 years from 2007 (the safe storage decay period was determined based on the radiological inventory and radiation levels in 2007), or in the year 2072.
  - This predicted time was calculated based on activation analysis, and the calculations were supported by measurements of actual dose rates.
  - Radiation levels from the small highly activated components (transition plate and anti-critical grid) were within the bounds of expected levels when measured in a reactor vessel internal survey in 2009.
  - When the control rod blades were removed from the reactor, radiation levels and curie contents were in close agreement with the predicted levels.
  - Based on this close agreement between actual and predicted radiation levels, the calculated dose rates for the large activated components are also expected to be reasonably accurate. Therefore, there is no justification to change the safe storage (decay) period of 65 years.

HFBR 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 HFBR 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 HFBR complex has been either removed or stabilized as a result of the 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 HFBR.

- The remaining remedial actions to be implemented for Building 802 (Fan House) removal and stack demolition are also expected to meet the overall ROD remedial action objectives.

HFBR 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 HFBR 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 HFBR remedy.

7.10 Other Areas

In 2005, additional radiological contamination was identified in surface soil in a number of discrete locations within wooded areas adjacent to the northeastern, northwestern, and southeastern corners of the former HWMF. The contamination is believed to be a result of historical operations associated with the transfer and management of wastes to and within the former HWMF and historical stormwater runoff from contaminated soils within the facility.

The cleanup of the former HWMF Perimeter Area has occurred in various stages and was performed as a non-time-critical removal action authorized by the Final Action Memorandum, *Removal Action for Contaminated Soil from the Former Hazardous Waste Management Facility Perimeter Area* (BNL 2009c) using the same cleanup goals and methodology required for radiologically contaminated soils in the OU I ROD. In late 2009, an extensive cleanup was completed through an ARRA-funded Environmental Management project, considered as Phase I of the cleanup, and was documented in the April 2010 *Final Completion Report for the Former Hazardous Waste Management Facility Perimeter Area Soil Remediation* (BNL 2010a). In 2010, cleanup of an 11-acre section of the Long Island Solar Farm (LISF) Project area, located to the southeast of the former HWMF and adjacent to the previously remediated former HWMF Perimeter Area was completed. This area is designated as Phase II and documented in the December 2010 *Addendum to the Former Hazardous Waste Management Facility Perimeter Area Completion Report* (BNL 2010b).

Institutional controls for the Phase 1 and Phase II areas are being implemented. For the Phase II area that was granted to the LISF in December 2010 via an easement from DOE, institutional controls include that no soil be removed from that area. The cleanup of Phase II allowed for industrial reuse as the solar farm.

Additional discrete areas of soil contamination within the former HWMF Perimeter Area that were not addressed in the Phase I and II investigations will be investigated and remediated, as necessary, in future remedial efforts, referred to as Phase III.

7.11 Technical Assessment Summary

Currently, nine RODs have been signed at BNL. The first was signed in 1996 and the last was signed in 2009. With the exception of the BGRR engineered cap and bioshield removal, and the HFBR stack and Building 802 demolition, all selected remedies for the nine 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.

Remedies have been implemented in accordance with the RODs and the ESDs, 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 BGRR and HFBR will be implemented in accordance with the RODs.

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 ESDs have either been met or are expected to be met. There is no other information that calls into question the protectiveness of the remedies.

8.0 Issues

Issues are identified in **Section 9**, **Table 9-1**.

9.0 Recommendations and Follow-up Actions

The following table summarizes key recommendations developed in the Technical Assessment section of this document. These recommendations are subject to regulatory review and implementation will be based on the availability of funding.

Table 9-1: Recommendations and Follow-up Actions

Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Capture of remaining VOCs in OU I Plume	Implement pulse pumping of extraction wells. Continue pumping until 2015 to meet VOC capture goal.	BNL	DOE, EPA, NYSDEC, SCDHS	July 2011	N	N
Sr-90 in OU I Groundwater	Enhance monitoring well network to track Sr-90.	BNL	DOE, EPA, NYSDEC, SCDHS	June 2011	N	N
OU III Building 96 Source Removal Effectiveness	Continue treatment system operations. Monitor plume and determine if continuing source remains.	BNL	DOE, EPA, NYSDEC, SCDHS	September 2012	N	N
Monitoring of downgradient OU III Industrial Park East Plume	Install additional downgradient monitoring well.	BNL	DOE, EPA, NYSDEC, SCDHS	August 2011	N	N
OU III Industrial Park Treatment System Shutdown	Install additional temporary well between UVB-3 and UVB-4 in support of anticipated system shutdown.	BNL	DOE, EPA, NYSDEC, SCDHS	August 2011	N	N
OU III North Street Treatment System Shutdown	Increase system operation through 2013 due to continued high VOCs	BNL	DOE, EPA, NYSDEC, SCDHS	October 2012	N	N
OU III North Street East Treatment System Shutdown	Characterize contamination upgradient of NSE-1 and monitor for achievement of capture goal. Extend system operation through 2013 to achieve system capture goal.	BNL	DOE, EPA, NYSDEC, SCDHS	September 2011	N	N
OU III Middle Road Treatment System	Assess contamination to west of RW-1 and need for additional extraction well.	BNL	DOE, EPA, NYSDEC, SCDHS	September 2012	N	N
OU III South Boundary deep VOC contamination	Install additional extraction well(s) to capture and treat deeper contamination. Extend system operation until 2017.	BNL	DOE, EPA, NYSDEC, SCDHS	September 2012	N	N
OU III Western South Boundary TCA/Freon contamination	Extend operation of extraction well WSB-1 to 2019 to capture high TCA concentrations. Characterize extent of Freon contamination and develop path forward.	BNL	DOE, EPA, NYSDEC, SCDHS	November 2012	N	N

Continued...

Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
OU III HFBR contingency pumping termination	Determine shutdown of pump and recharge system based on characterization of high-concentration slug.	BNL	DOE, EPA, NYSDEC, SCDHS	March 2012	N	N
OU IV Sump Outfall Sr-90	Install additional monitoring wells as per *2009 Groundwater Status Report* Recommendations.	BNL	DOE, EPA, NYSDEC, SCDHS	October 2011	N	N
OU V Groundwater	Petition regulatory agencies to conclude groundwater monitoring program pending 2011 perchlorate results.	BNL	DOE, EPA, NYSDEC, SCDHS	December 2011	N	N
Potential continuing Sr-90 source at BGRR	Monitor to determine existence and assess feasibility of in-situ source stabilization. Monitor the effectiveness of new extraction wells.	BNL	DOE, EPA, NYSDEC, SCDHS	July 2012	N	N
Potential continuing Sr-90 source at Chemical Holes	Monitor to determine existence and assess feasibility of in-situ source stabilization and/or removal.	BNL	DOE, EPA, NYSDEC, SCDHS	July 2012	N	N
Peconic River Monitoring Program	Modify monitoring program following remedy optimization.	BNL	DOE, EPA, NYSDEC, SCDHS	September 2011	N	N
OU VI EDB	Add new monitoring well to bound the east side of the plume	BNL	DOE, EPA, NYSDEC, SCDHS	September 2011	N	N
BGRR Decommissioning	Complete remaining remedial actions and submit closeout report(s) to the regulators	BNL	DOE, EPA, NYSDEC, SCDHS	October 2012	N	N
HFBR	Complete remaining remedial actions and submit closeout report(s) to the regulators	BNL	DOE, EPA, NYSDEC, SCDHS	October 2011	N	N
HFBR	Explore the feasibility of reducing the 65-year safe storage (decay) period and completing the removal of large activated components earlier.	BNL	DOE, EPA, NYSDEC, SCDHS	Recurring	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, NYSDEC, SCDHS	June 2005 (survey/mapping completed 6/30/05)	N	Y
Former HWMF Perimeter Soils	Phase III Assess soil contamination Additional cleanup if necessary	BNL	DOE, EPA, NYSDEC, SCDHS	September 2012 September 2014	N	N

Notes
Recommendations are subject to regulatory review, and implementation will be based on the availability of funding
BGRR = Brookhaven Graphite Research Reactor
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
HFBR = High Flux Beam Reactor
NYSDEC = New York State Department of Environmental Conservation
SCDHS = Suffolk County Department of Health Services
VOCs = volatile organic compounds

10.0 Protectiveness Statements

Individual Protectiveness Statements

Protectiveness statement for the individual OUs, the BGRR, HFBR, and g-2/BLIP/USTs are presented below.

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

- All soil cleanup actions are complete and the groundwater treatment system is operational. The attainment of groundwater cleanup goals is expected to require 30 years or less to achieve (by 2030). 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.
- 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 is documented in another 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 is identified below.

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 (by 2030).
  - 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 (by 2040 and 2070, respectively).
  - 65 years or less to achieve MCLs for VOCs in the Magothy aquifer (by 2065).
- 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 protective of human health and the environment. 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 oil/solvent 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.
- Additional groundwater characterization performed in 2010 (and updated groundwater modeling) verified that the remaining Sr-90 contamination in groundwater will remain in the central portion of the site and attenuate to below MCLs by 2034.

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 has been excavated to meet the appropriate cleanup levels. Revegetation of remediated areas has been completed. The monitoring program has demonstrated 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 has been achieved following five years of sediment, surface water, fish, and revegetation monitoring and supplemental removal of sediment in several targeted areas of the river. A long-term monitoring plan is in place. In addition to periodic reporting of the analytical results, the monitoring data is evaluated and summarized in the annual *Site Environmental Report* that is submitted to and reviewed with and by the DOE, EPA, NYSDEC, and SCDHS.

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 (by 2030).
- 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 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, installation of signs, building access controls, and the implementation of specific institutional controls for the structures, 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 of the infiltration management system, and groundwater monitoring required as part of the OU III ROD and the ESD.

g-2/BLIP/USTs: The remedy defined in the ROD is expected to be protective of human health and the environment, and institutional controls are in place that are designed to prevent exposure to contaminated structures, soil, and groundwater. Long-term protectiveness of the remedy will be verified by continuing inspections and maintenance of the g-2 and BLIP facility stormwater controls, and groundwater monitoring required by the ROD.

HFBR: 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 near-term actions (demolition of the fan house and stack, and remediation of associated soils), and the segmentation, removal, and disposal of the remaining HFBR structures, systems, and components (including the reactor vessel, internals, thermal shield and biological shield) following a safe storage decay period (not to exceed 65 years). 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, installation of signs, building access controls, and the implementation of specific institutional controls for the structures, soil and groundwater.
- Long-term protectiveness of the remedy will be verified by continuing to perform health and safety monitoring, periodic structural inspections of the reactor confinement building, water intrusion monitoring, preventive maintenance of the infiltration management system, and groundwater monitoring required as part of the OU III ROD.

Other Area: The remedy is expected to be protective upon attainment of soil cleanup goals once the assessment and potential remediation of the former HWMF perimeter soils Phase III is complete. 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 soil.

Comprehensive Protectiveness Statement

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

- BGRR remedy implementation is not yet complete. Dismantling of the BGRR bioshield and installation of the engineered cap are currently in progress.
- HFBR remedy implementation is also underway. Removal of Building 802 (Fan House) and planning for stack demolition are currently in progress.

11.0 Next Review

The third 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), the BGRR and HFBR RODs. A comprehensive sitewide protectiveness determination will be included at that time.

For John Sattler, Brookhaven Federal Project Director
Office of Environmental Management
U.S. Department of Energy

29 MAR 2011
Date

M. Holland

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

3/30/11
Date

This page intentionally left blank.

12.0 References

BNL. 1996. *Brookhaven National Laboratory Operable Unit IV Record of Decision*. Upton, NY.

BNL. 1997. *Animal/Chemical Pits and Glass Holes Remedial Action Closure Report.* October 1997. Upton, NY.

BNL. 1999a. *Record of Decision, Operable Unit I and Radiologically Contaminated Soils (Including Areas of Concern 6, 8, 10, 16, 17, and 18)*. Upton, NY.

BNL. 1999b. *Final Focused Ecological Risk Assessment for OU I.* Upton, NY.

BNL. 2000a. *Brookhaven National Laboratory Operable Unit III Record of Decision*. Upton, NY.

BNL. 2000b. *Brookhaven National Laboratory Operable Unit VI Record of Decision*, Upton, NY.

BNL. 2001a. *Current Landfill Area Five-Year Evaluation Final Report*. Upton, NY.

BNL. 2001b. *Brookhaven National Laboratory Operable Unit V Record of Decision for AOC 4 (Sewage Treatment Plant), AOC 21 (Sewer Lines), AOC 23 (Eastern Off-site Tritium Plume)*. Upton, NY.

BNL. 2001c. *Final Closeout Report for Area of Concern 16 Landscape Soils.* Upton, NY.

BNL. 2001d. *BLIP Closeout Report Removal Action AOC 16K*. Upton, NY.

BNL. 2002. *Former Landfill Area Five-Year Evaluation Report.* Upton, NY.

BNL. 2002-2009. Operation and Maintenance Manuals for Groundwater Treatment Systems. Available on-line at http://www.bnl.gov/ltra/reports.asp

BNL. 2003b. *Natural Resource Management Plan for Brookhaven National Laboratory.* Upton, NY.

BNL. 2003c. *BNL Environmental Monitoring Plan Triennial Update.* Upton, NY.

BNL. 2004a. *Brookhaven National Laboratory Final Operable Unit V Record of Decision for Area of Concern 30 (Peconic River)*. Upton, NY.

BNL 2004b. *Final Completion Report Remedial Action AOC 4 STP, Sludge Drying Beds and Sand Filter Beds/Berms, AOC 21 Abandoned Former Sewer Lines*. Upton, NY.

BNL. 2004c. *Peconic River Removal Action for Sediment on BNL Property* (Action Memorandum). Upton, NY.

BNL. 2004d. *Final Closeout Report for the Meadow Marsh Operable Unit I Area of Concern 8*. Upton, NY.

BNL. 2004e. *Final Closeout Report for the Ash Pit Operable Unit I Area of Concern 2F.* Upton, NY.

BNL. 2004f. *Remedial Investigation and Soil Remediation Evaluation and Cost Estimate for the Central Steam Facility Storm Water Outfall.* Upton, NY.

BNL. 2005a. *Operable Unit III Explanation of Significant Differences*. February 28, 2005. Upton, NY.

BNL. 2005b. *Brookhaven National Laboratory, Final Record of Decision for Area of Concern 9, Brookhaven Graphite Research Reactor.* Upton, NY.

BNL. 2005c. *Final Closeout Report for Peconic River Remediation Phases 1 and 2.* Upton, NY.

BNL. 2005d. *BNL Land Use Controls Management Plan.* Upton, NY.

BNL. 2005e. *OU III Building 96 PCB Soil (AOC 26B) Excavation Closeout Report*. Upton, NY.

BNL 2005f. *BNL Animal/Chemical Pits and Glass Holes Remedial Action Closure Report Addendum.* Upton, NY.

BNL. 2005g. *OU III Building 96 Groundwater Treatment System Shutdown Petition (AOC 26B)*. Upton, NY.

BNL. 2005h. *2004 BNL Groundwater Status Report*. Upton, NY.

BNL. 2005j. *Final Closeout Report for the Brookhaven Graphite Research Reactor, Final Canal and Deep Soil Pockets Excavation and Removal.*

BNL. 2006a. *Final Five-Year Review Report for Brookhaven National Laboratory Superfund Site.* Upton, NY.

BNL. 2006b. *Operable Unit I Soils and Operable Unit V Long-Term Monitoring and Maintenance Plan*. Upton, NY.

BNL. 2007a. *BNL Land Use Controls Management Plan.* Upton, NY.

BNL. 2007b. *Brookhaven National Laboratory Record of Decision for Area of Concern 16T g-2 Tritium Source Area and Groundwater Plume, Area of Concern 16T Brookhaven Linac Isotope Producer, and Area of Concern 12 Former Underground Storage Tanks.* April 6, 2007. Upton, NY.

BNL. 2007c. *Central Steam Facility Storm Water Outfall Remediation Closeout Report.*

BNL. 2007d. *Brookhaven National Laboratory, Action Memorandum, High Flux Beam Reactor, Removal Action for Waste Loading Area.* Upton, NY.

BNL. 2007e. *Investigation and Characterization of the Brookhaven Avenue Cs-137 Contamination*.

BNL. 2007f. *BNL High Flux Beam Reactor Characterization Summary Report, Rev 1.*

BNL. 2007g. *Final 2006 Peconic River Monitoring Report.* Upton, NY.

BNL. 2008a. *2007 BNL Groundwater Status Report*. Upton, NY.

BNL. 2008b. *Final 2007 Peconic River Monitoring Report.* Upton, NY.

BNL. 2008c. *Brookhaven National Laboratory, Action Memorandum, High Flux Beam Reactor, Removal Action for Control Rod Blades and Beam Plugs.* Upton, NY.

BNL. 2009a. *Final Operable Unit III Explanation of Significant Differences for Building 96 Remediation.* Upton, NY.

BNL. 2009b. *Brookhaven National Laboratory, Final Record of Decision for Area of Concern 31, High Flux Beam Reactor.* Upton, NY.

BNL. 2009c. *Final Action Memorandum, Removal of Contaminated Soil from the Former Hazardous Waste Management Facility Perimeter Area.* Upton, NY.

BNL. 2009d. *Brookhaven National Laboratory, High Flux Beam Reactor, Area of Concern 31, Final Completion Report for Waste Loading Area Soil Remediation.* Upton, NY.

BNL. 2009e. *BNL Land Use Controls Management Plan.* Upton, NY.

BNL. 2009f. *2008 BNL Groundwater Status Report*. Upton, NY.

BNL. 2009g. *Final 2008 Peconic River Monitoring Report.* Upton, NY.

BNL. 2009h. *Environmental Monitoring Report – Current and Former Landfills.* Upton, NY.

BNL. 2010a. *Final Completion Report for the Former Hazardous Waste Management Facility Perimeter Area Soil Remediation, April 2010.* Upton, NY.

BNL 2010b. *Addendum to the Former Hazardous Waste Management Facility Perimeter Area Completion Report. December 2010.* Upton, NY.

BNL. 2010c. *Final Closeout Report for the Brookhaven Graphite Research Reactor, Graphite Pile Removal, Area of Concern 9.*

BNL. 2010d. *Final Closeout Report for Removal of the Building 801-811 Waste Transfer Lines (A/B Waste Lines with Co-Located Piping) Area of Concern 31.* Upton, NY.

BNL. 2010e. *BNL Environmental Monitoring Plan Annual Update*. Upton, NY.

BNL. 2010f. *2009 BNL Groundwater Status Report*. Upton, NY.

BNL. 2010g. *Final Plan for the Optimization of the Peconic River Remedy.* Upton, NY.

BNL. 2010h. *Brookhaven National Laboratory, High Flux Beam Reactor Decommissioning Project, Area of Concern 31, Final Completion Report for Removal of Control Rod Blades and Beam Plugs.* Upton, NY.

BNL. 2010i. *Final 2009 Peconic River Monitoring Report.* Upton, NY.

BNL 2011. *Long-Term Surveillance and Maintenance Plan for the HFBR.*

DOE. 2003. Order 450.1. *Environmental Protection Program*. U.S. Department of Energy, Washington DC. 1-15-03.

Envirocon. 2004. *Completion Report for Peconic River Remediation on BNL Property*.

Envirocon. 2005. *Closeout Report for the Former Hazardous Waste Management Facility.*

EPA. 2001. *EPA Five-Year Guidance.* Environmental Protection Agency, Washington, DC.

New York State. 1992. NYS 6 NYCRR Part 360, Regulations. *Solid Waste Management Facilities*. 1992, Revision in progress.

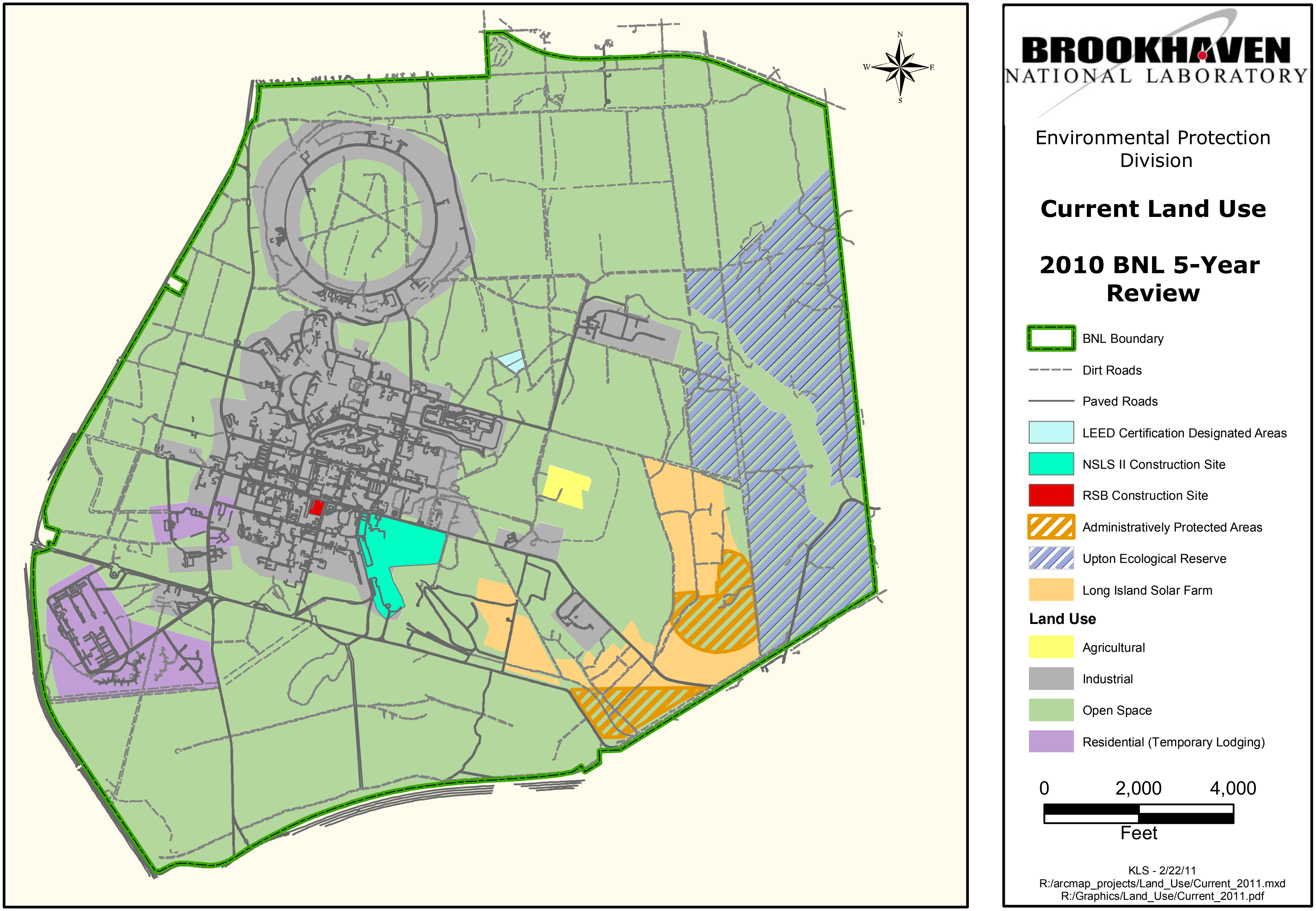
ORISE 2008. *Data Evaluation and Dose Modeling for the Former Hazardous Waste Management Facility, Brookhaven National Laboratory, Upton, New York, Revision 1.*

SCDHS. *Article 4 of the Suffolk County Sanitary Code* (private water system standards).

Figures

(Figures 3-1 through 7-1)

FIGURE 3-1



Environmental Protection Division

Current Land Use

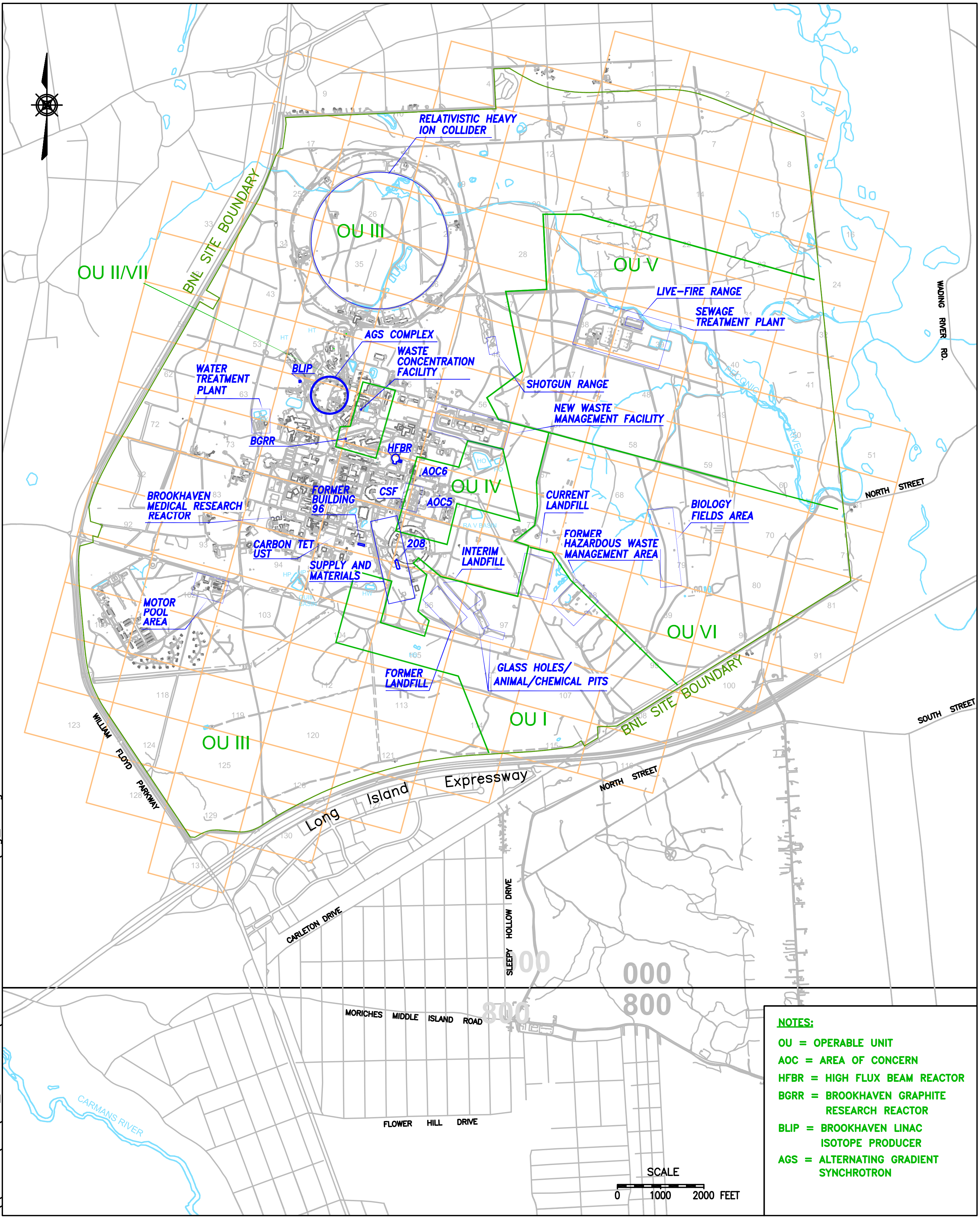
2010 BNL 5-Year Review

- BNL Boundary
- Dirt Roads
- Paved Roads
- LEED Certification Designated Areas
- NSLS II Construction Site
- RSB Construction Site
- Administratively Protected Areas
- Upton Ecological Reserve
- Long Island Solar Farm

Land Use

- Agricultural
- Industrial
- Open Space
- Residential (Temporary Lodging)

KLS - 2/22/11
R:/arcmap_projects/Land_Use/Current_2011.mxd
R:/Graphics/Land_Use/Current_2011.pdf



NOTES:

OU = OPERABLE UNIT
AOC = AREA OF CONCERN
HFBR = HIGH FLUX BEAM REACTOR
BGRR = BROOKHAVEN GRAPHITE RESEARCH REACTOR
BLIP = BROOKHAVEN LINAC ISOTOPE PRODUCER
AGS = ALTERNATING GRADIENT SYNCHROTRON

\\OERNT\GIS\GW_PROJECTS\Five Year Review – 2010\Fig_2.dwg

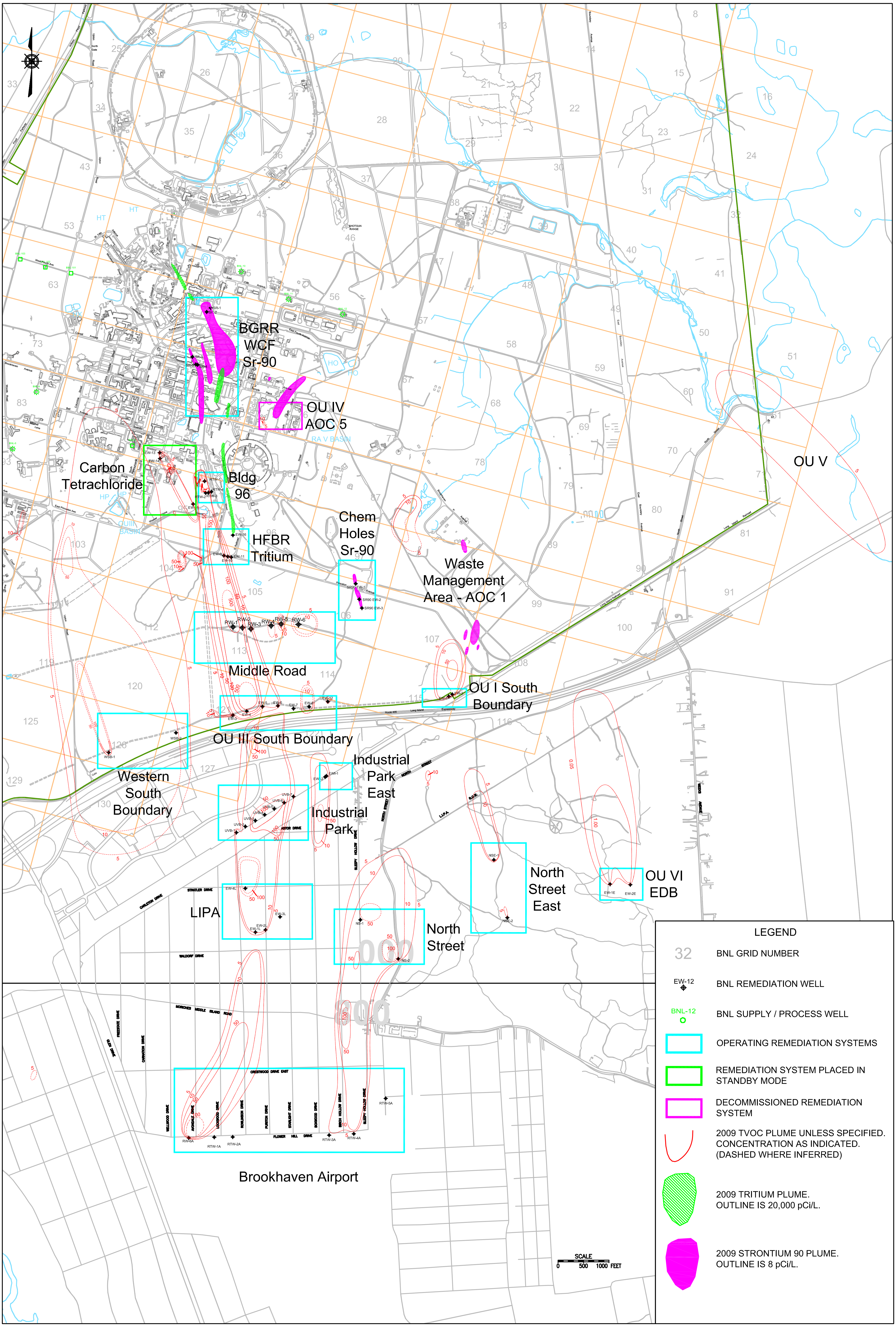
BROOKHAVEN
NATIONAL LABORATORY
ENVIRONMENTAL
PROTECTION DIVISION

TITLE:

OU LOCATIONS

2010 BNL FIVE–YEAR REVIEW

DWN: AJZ	VT: HZ.: –	DATE: 02/22/11	PROJECT NO.: –
CHKD: JEB	APPD: WRD	REV.: –	NOTES: –
FIGURE NO.: 4–1			



\\OERNT\GIS\GW_PROJECTS\Five Year Review – 2010\Fig_4–2.dwg

BROOKHAVEN
NATIONAL LABORATORY

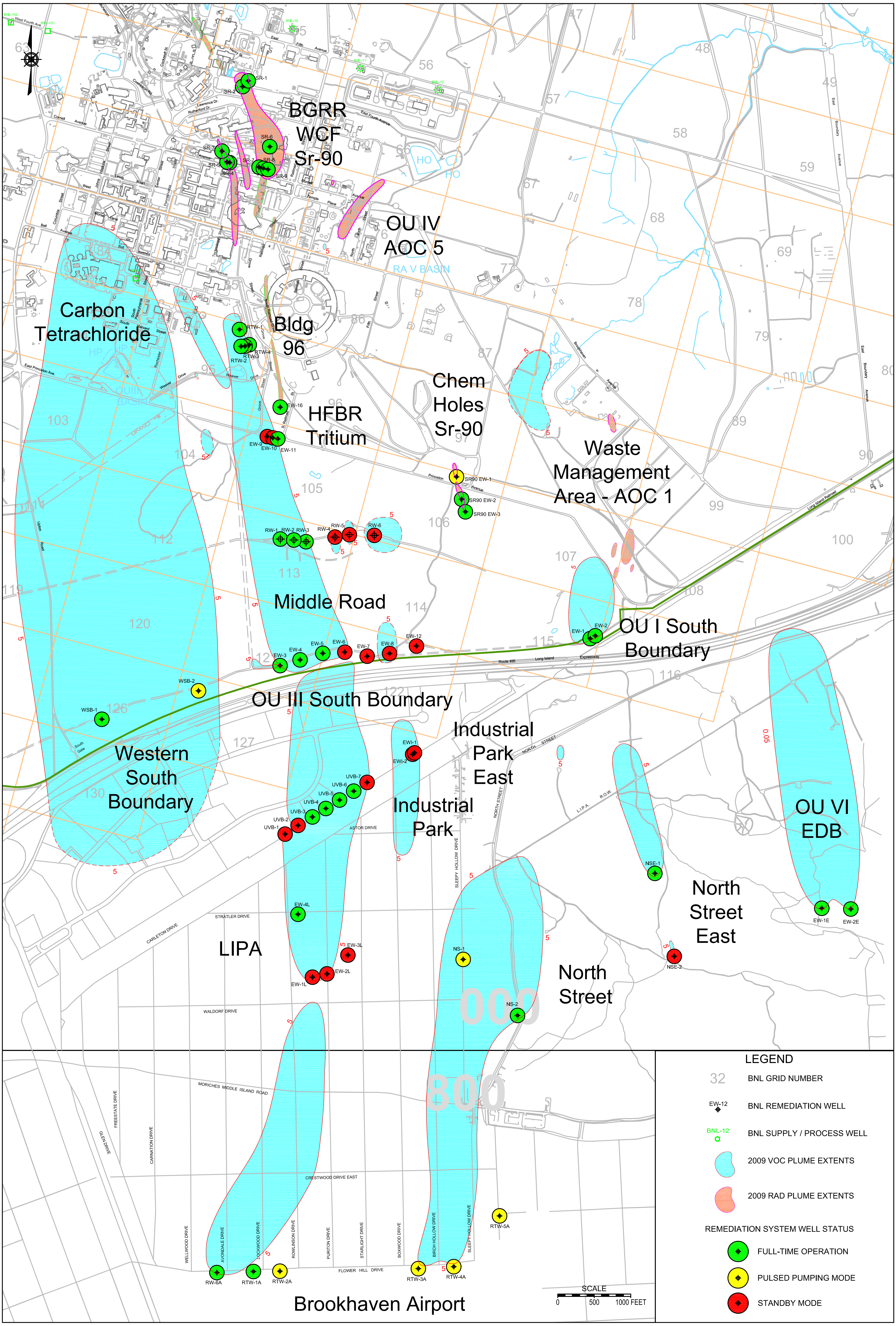
ENVIRONMENTAL PROTECTION DIVISION

TITLE:

GROUNDWATER REMEDIATION SYSTEMS

2010 BNL FIVE-YEAR REVIEW

DWN: AJZ	VS: HS.: –	DATE: 02/22/11	PROJECT NO.: –
CHKD: –	APPD: –	REV.: –	NOTES: –
FIGURE NO.: 4–2			



\\OERNT\GIS\GW_PROJECTS\FIVE YEAR REVIEW – 2010\FIVE YEAR FIG 03 021111.DWG

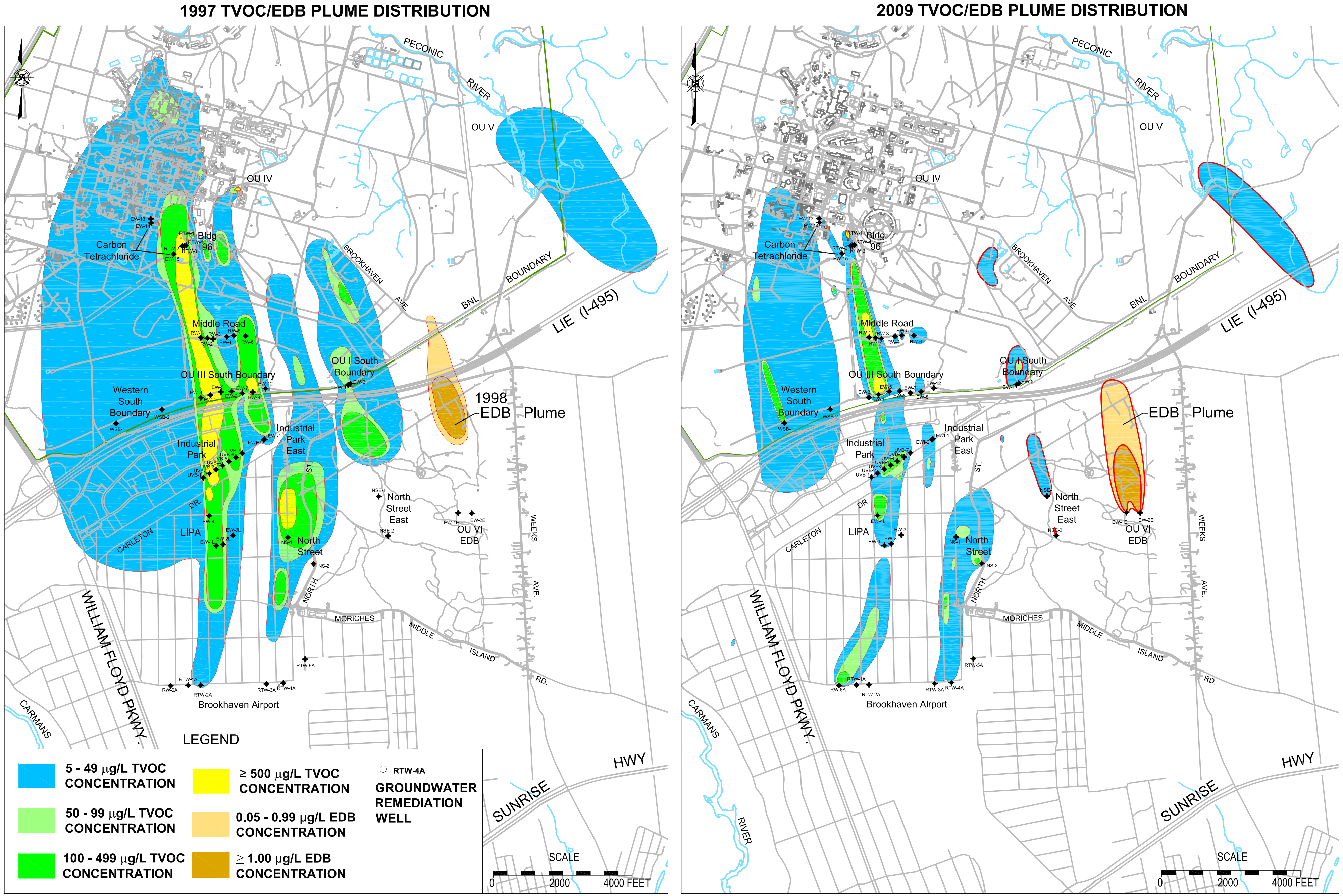
BROOKHAVEN
NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:
OPERATIONAL STATUS OF
GROUNDWATER REMEDIATION SYSTEM WELLS
2010 BNL FIVE-YEAR REVIEW

DWN: AJZ
VS: HS.: –
DATE: 02/22/11
PROJECT NO.: –
CHKD: –
APPD: –
REV.: –
NOTES: –
FIGURE NO.: 4–3

\\OERNT\GIS\GW_PROJECTS\FIVE YEAR REVIEW - 2010\FIVE YEAR FIG 04 020811.DWG



1997 TVOC/EDB PLUME DISTRIBUTION

2009 TVOC/EDB PLUME DISTRIBUTION

BROOKHAVEN
NATIONAL LABORATORY

ENVIRONMENTAL
PROTECTION DIVISION

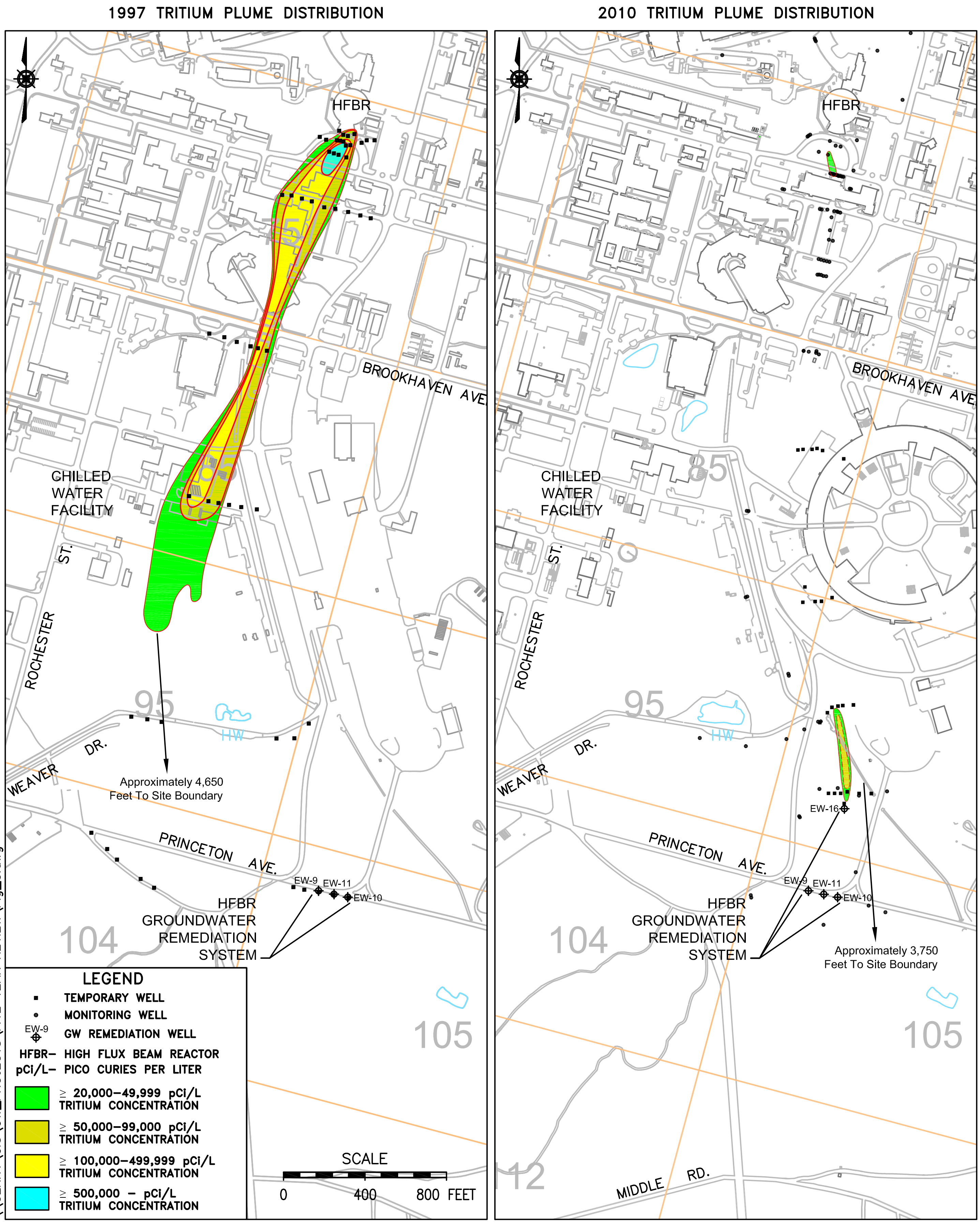
TITLE:

TVOC/EDB PLUME COMPARISON
1997/1998 - 2009

2010 BNL FIVE-YEAR REVIEW

DWN: AJZ	VT:HZ.: -	DATE: 02/22/11	PROJECT NO.: -
CHKD: -	APPD: -	REV.: -	NOTES: -

FIGURE NO.: 5-1



\\OERNT\GIS\GW_PROJECTS\FIVE YEAR REVIEW\Fig_5.dwg

BROOKHAVEN
NATIONAL LABORATORY

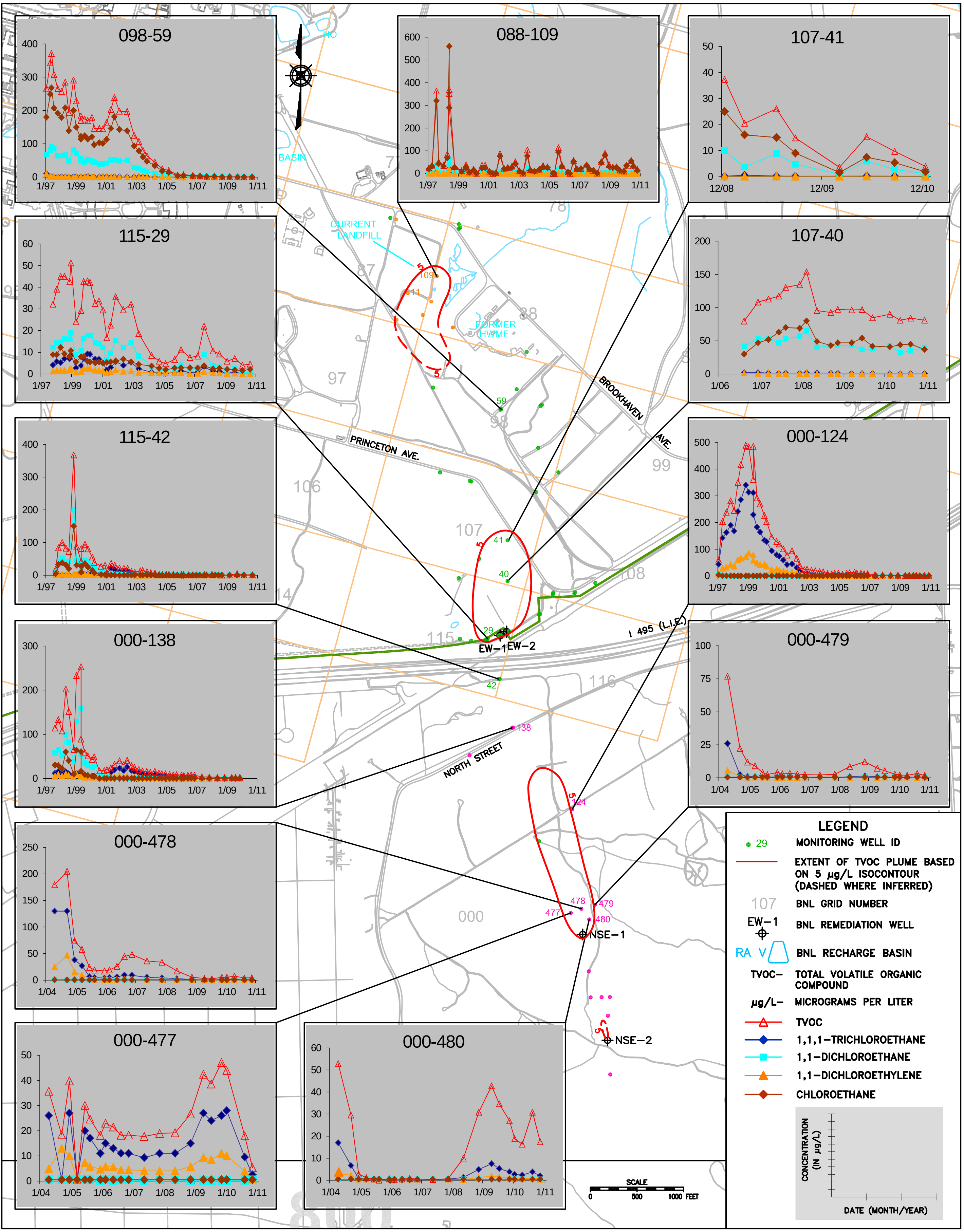
ENVIRONMENTAL
PROTECTION DIVISION

TITLE:

OU III HFBR AOC 29
TRITIUM PLUME COMPARISON
1997 – 2010

2010 BNL FIVE-YEAR REVIEW

DWN: AJZ
VT:HZ.: –
DATE: 02/22/11
PROJECT NO.: –
CHKD: JEB
APPD: WRD
REV.: –
NOTES: –
FIGURE NO.: 5–2



\\OERNT\GIS\GW_PROJECTS\FIVE YEAR REVIEW\Fig_6-1 022311.dwg

BROOKHAVEN
NATIONAL LABORATORY

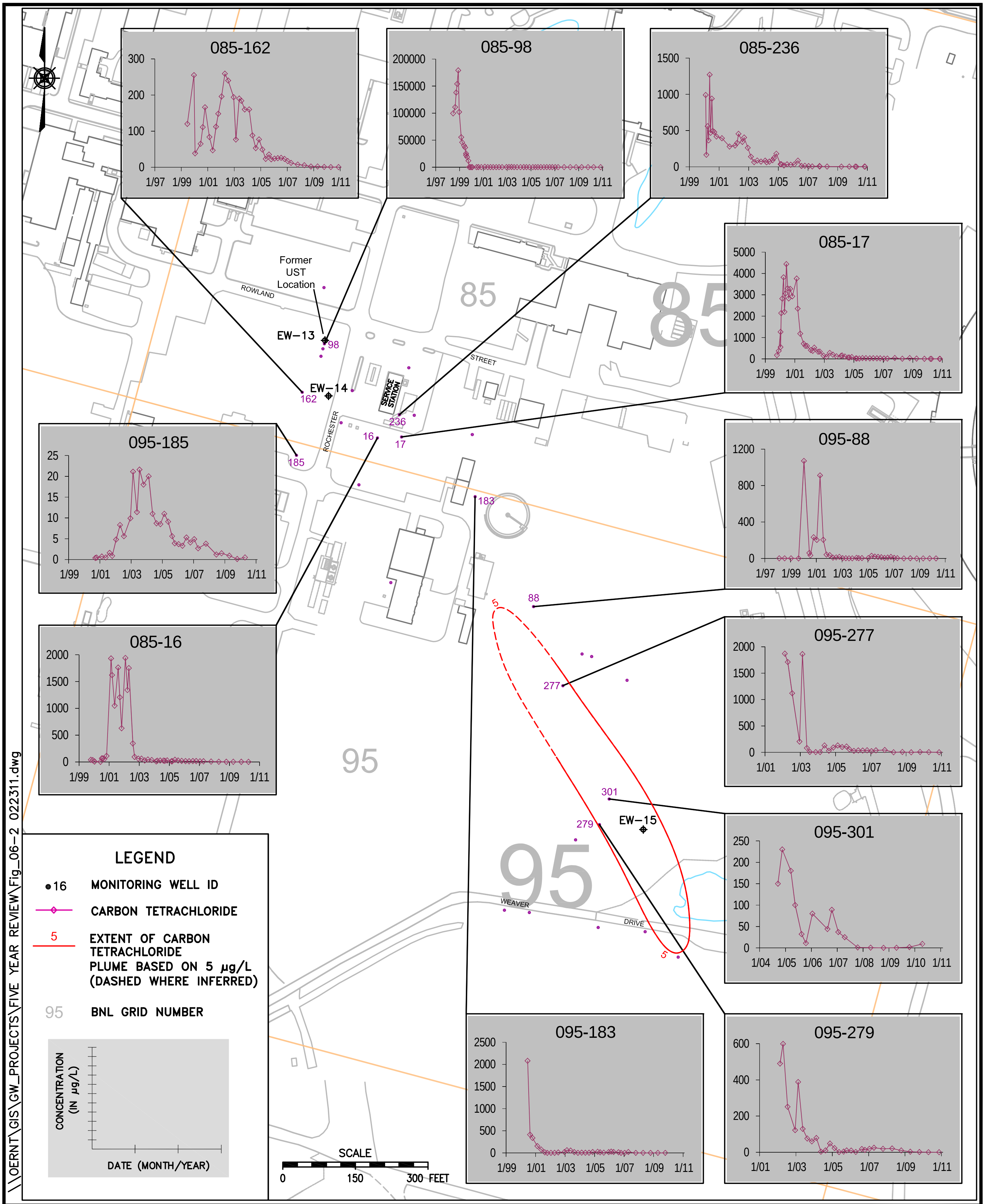
ENVIRONMENTAL
PROTECTION DIVISION

TITLE:

OU I CURRENT LANDFILL/ SOUTH BOUNDARY/ NORTH STREET EAST HISTORICAL VOC TRENDS

2010 BNL FIVE-YEAR REVIEW

DWN: AJZ
VT: HZ.: –
DATE: 02/23/11
PROJECT NO.: –
CHKD: JEB
APPD: WRD
REV.: –
NOTES: –
FIGURE NO.: 6-1



\\OERNT\GIS\GW_PROJECTS\FIVE YEAR REVIEW\Fig_06-2 022311.dwg

BROOKHAVEN NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

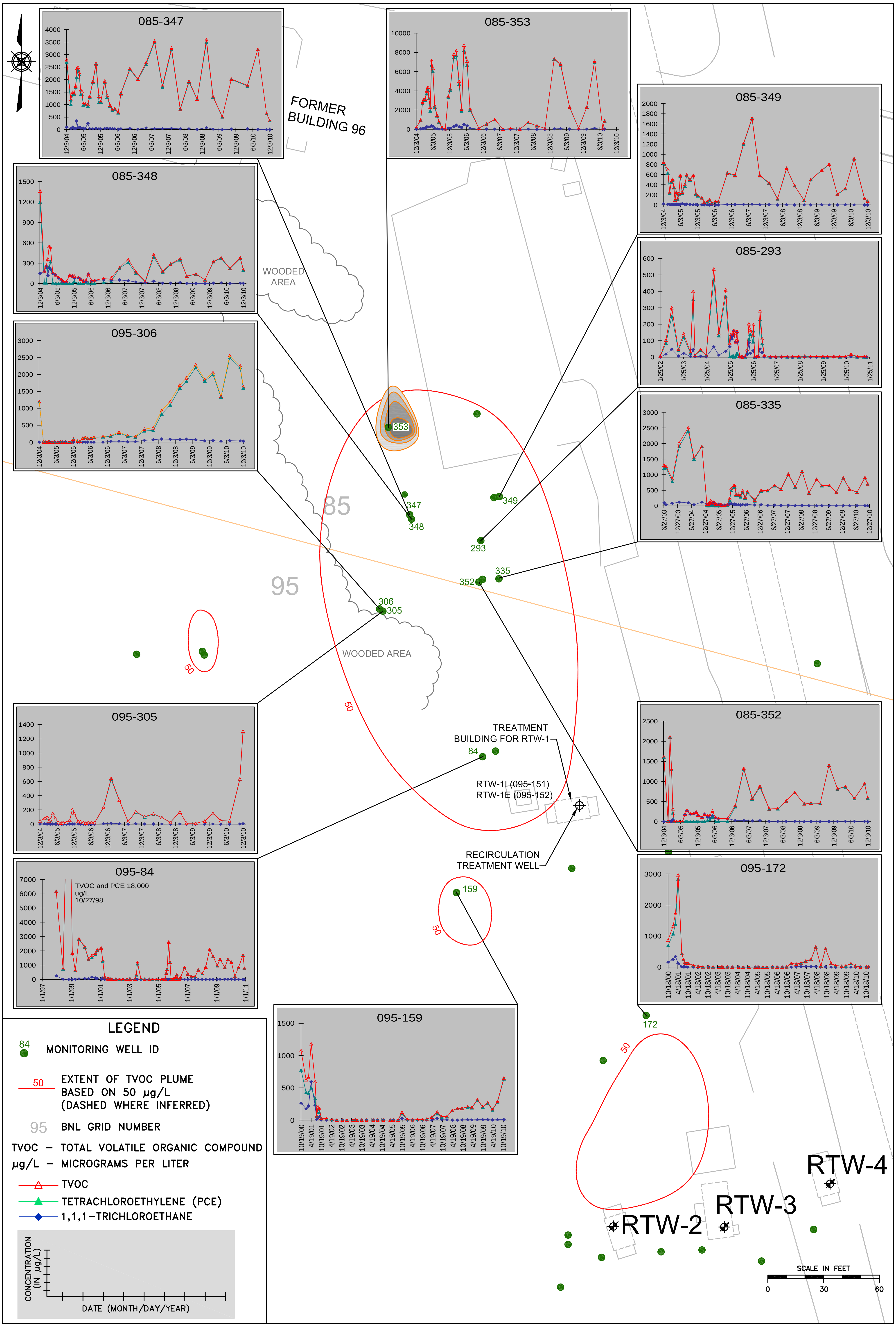
TITLE:

OU III CARBON TETRACHLORIDE HISTORICAL TRENDS

2010 BNL FIVE-YEAR REVIEW

DWN: AJZ	VT: HZ.: –	DATE: 02/23/11	PROJECT NO.: –
CHKD: JEB	APPD: WRD	REV.: –	NOTES: –

FIGURE NO.: 6–2



\\OERNT\GIS\GW_PROJECTS\FIVE YEAR REVIEW\Fig_06-3 022411.dwg

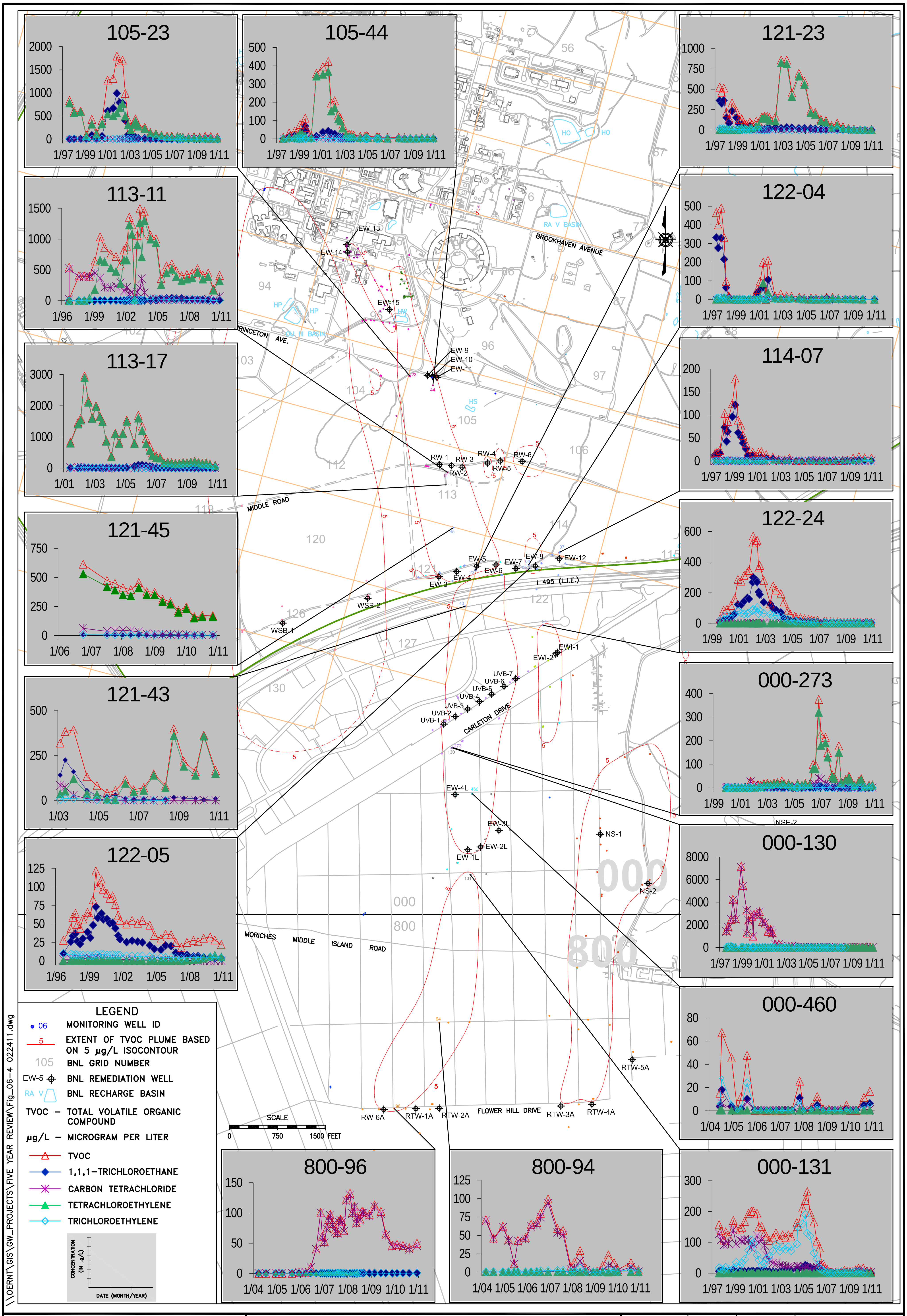
BROOKHAVEN
NATIONAL LABORATORY

ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III BUILDING 96 AREA
HISTORICAL VOC TRENDS
2010 BNL FIVE-YEAR REVIEW

DWN: AJZ	VS:HS.: –	DATE: 02/24/11	PROJECT NO.: –
CHKD: JEB	APPD: WRD	REV.: –	NOTES: –
FIGURE NO.: 6–3			



\\OERNT\GIS\GW_PROJECTS\FIVE YEAR REVIEW\Fig_06-4 022411.dwg

BROOKHAVEN
NATIONAL LABORATORY

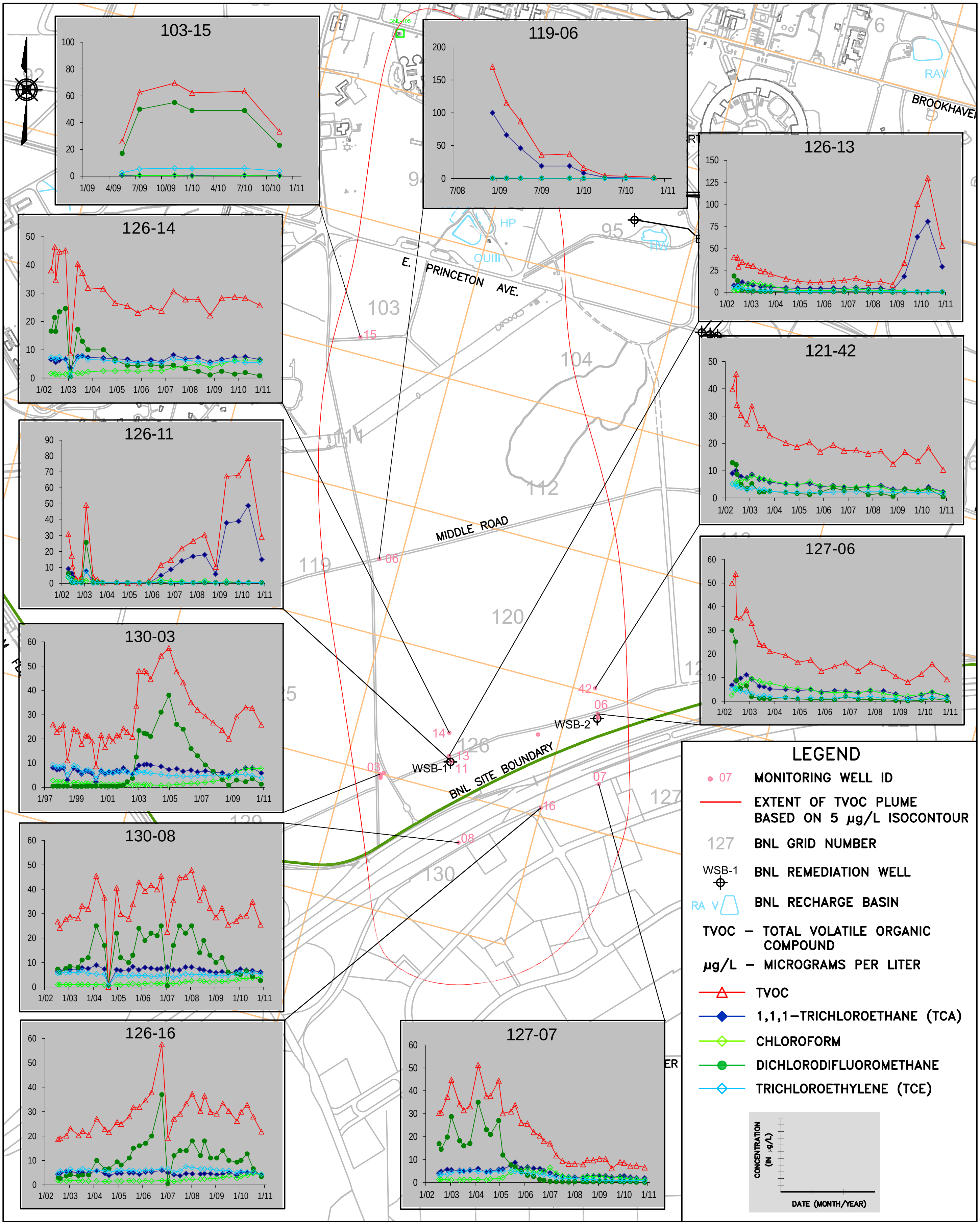
ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III AND OU IV PLUME(S)
HISTORICAL VOC TRENDS

2010 BNL FIVE-YEAR REVIEW

DWN: AJZ	VT:HZ.: –	DATE: 02/24/11	PROJECT NO.: –
CHKD: JEB	APPD: WRD	REV.: –	NOTES: –
FIGURE NO.: 6–4			



\\OERNT\GIS\GW_PROJECTS\FIVE YEAR REVIEW\Fig_06-5 022411.dwg

BROOKHAVEN
NATIONAL LABORATORY

ENVIRONMENTAL
PROTECTION DIVISION

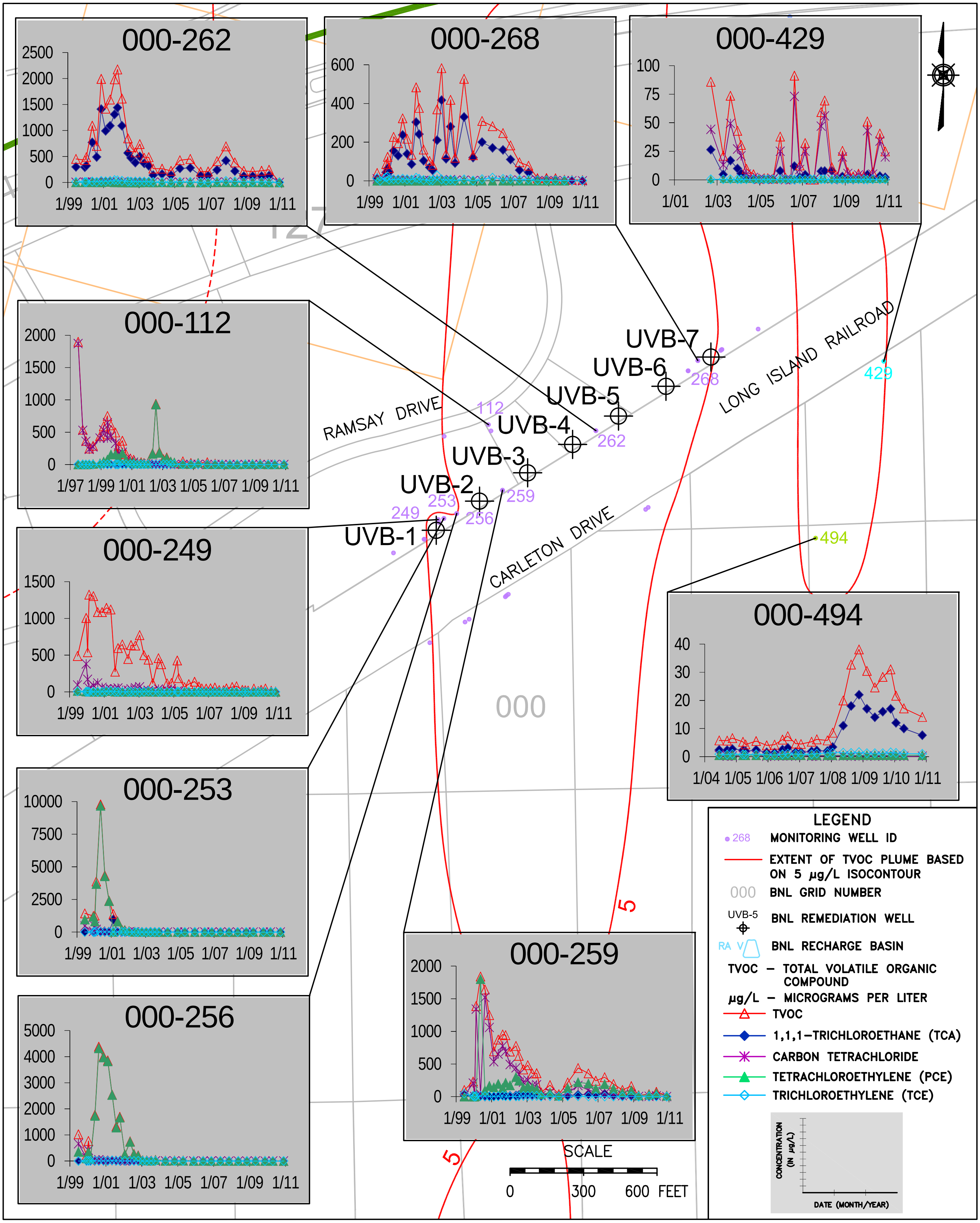
TITLE:

OU III WESTERN SOUTH BOUNDARY HISTORICAL VOC TRENDS

2010 BNL FIVE-YEAR REVIEW

DWN: AJZ	VT: HZ.: –	DATE: 02/24/11	PROJECT NO.: –
CHKD: JEB	APPD: WRD	REV.: –	NOTES: –

FIGURE NO.: 6–5



\\OERNT\GIS\GW_PROJECTS\Five Year Review\Fig_06–6 022411.dwg

BROOKHAVEN
NATIONAL LABORATORY

ENVIRONMENTAL
PROTECTION DIVISION

TITLE:

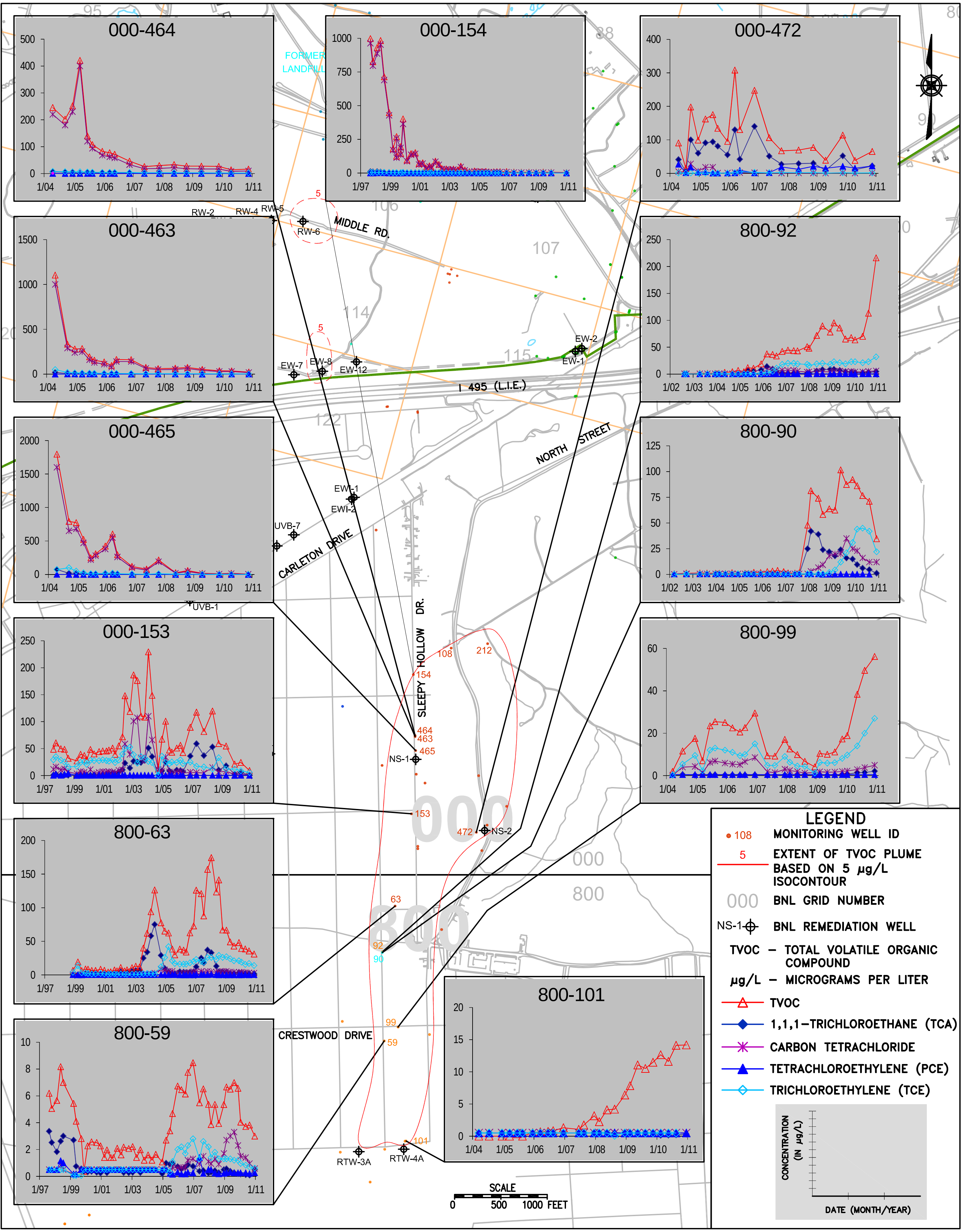
OU III INDUSTRIAL PARK
HISTORICAL VOC TRENDS

2010 BNL FIVE–YEAR REVIEW

DWN:	VT:HZ.:	DATE:	PROJECT NO.:
LR	–	02/24/11	–
CHKD:	APPD:	REV.:	NOTES:
JEB	WRD	–	–

FIGURE NO.: 6–6

\OERNT\GIS\GW_PROJECTS\Five Year Review\Fig_06-7 022411.dwg



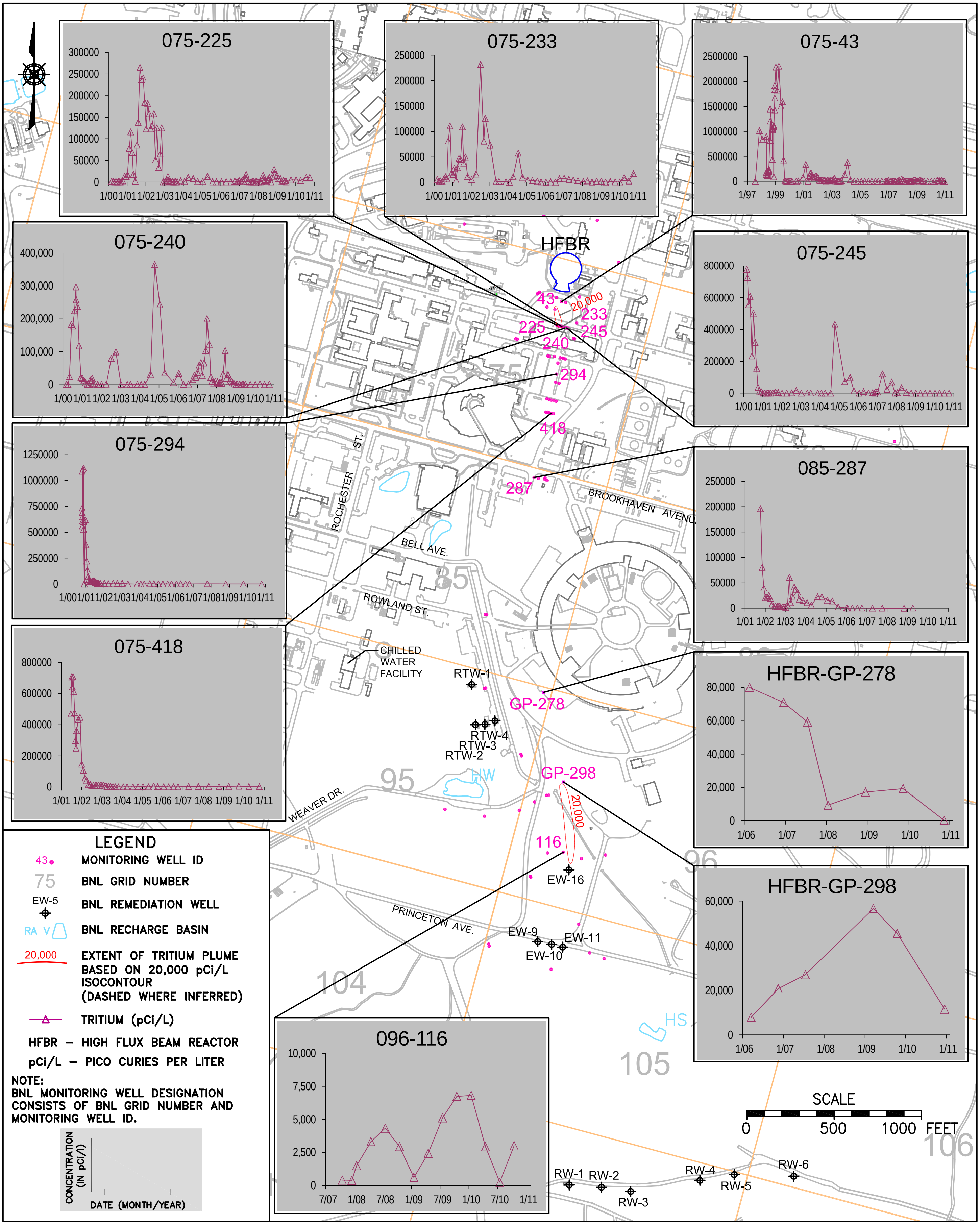
BROOKHAVEN
NATIONAL LABORATORY

ENVIRONMENTAL
PROTECTION DIVISION

TITLE:
NORTH STREET (OU I/IV FORMER LANDFILL,
CHEMICAL/ANIMAL HOLES)
HISTORICAL VOC TRENDS

2010 BNL FIVE-YEAR REVIEW

DWN: AJZ	VT: HZ.: –	DATE: 02/24/11	PROJECT NO.: –
CHKD: JEB	APPD: WRD	REV.: –	NOTES: –
FIGURE NO.: 6-7			



\\OERNT\GIS\GW_PROJECTS\Five Year Review – 2010\Fig_6-8 022211.DWG

BROOKHAVEN
NATIONAL LABORATORY

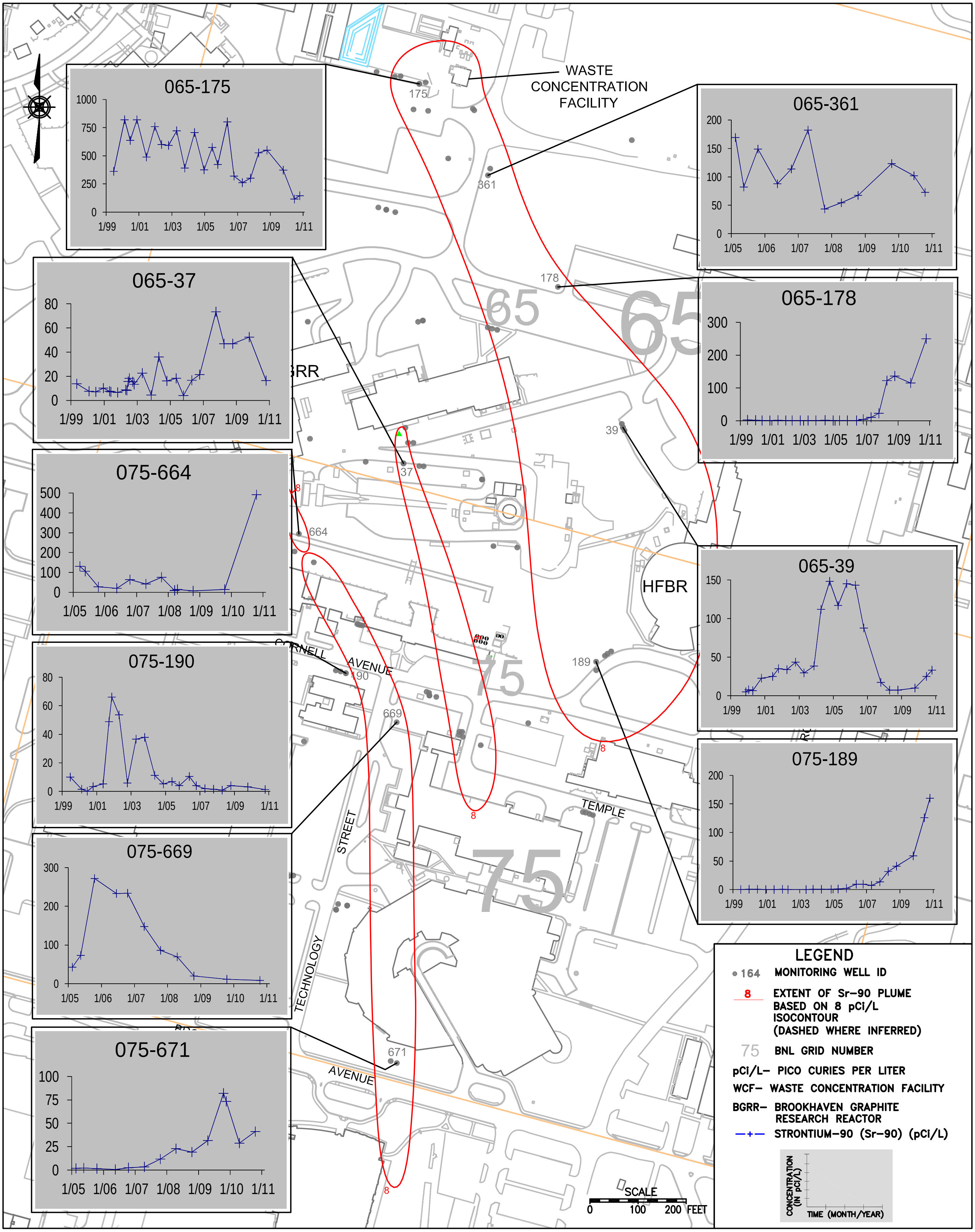
ENVIRONMENTAL
PROTECTION DIVISION

TITLE:

OU III HFBR AOC 29
HISTORICAL TRITIUM TRENDS
2010 BNL FIVE-YEAR REVIEW

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
DH	–	02/22/11	–
CHKD:	APPD:	REV.:	NOTES:
JEB	WRD	–	–

FIGURE NO.: 6–8



\\OERNT\GIS\GW_PROJECTS\Five Year Review – 2010\Fig_6-9.DWG

BROOKHAVEN
NATIONAL LABORATORY

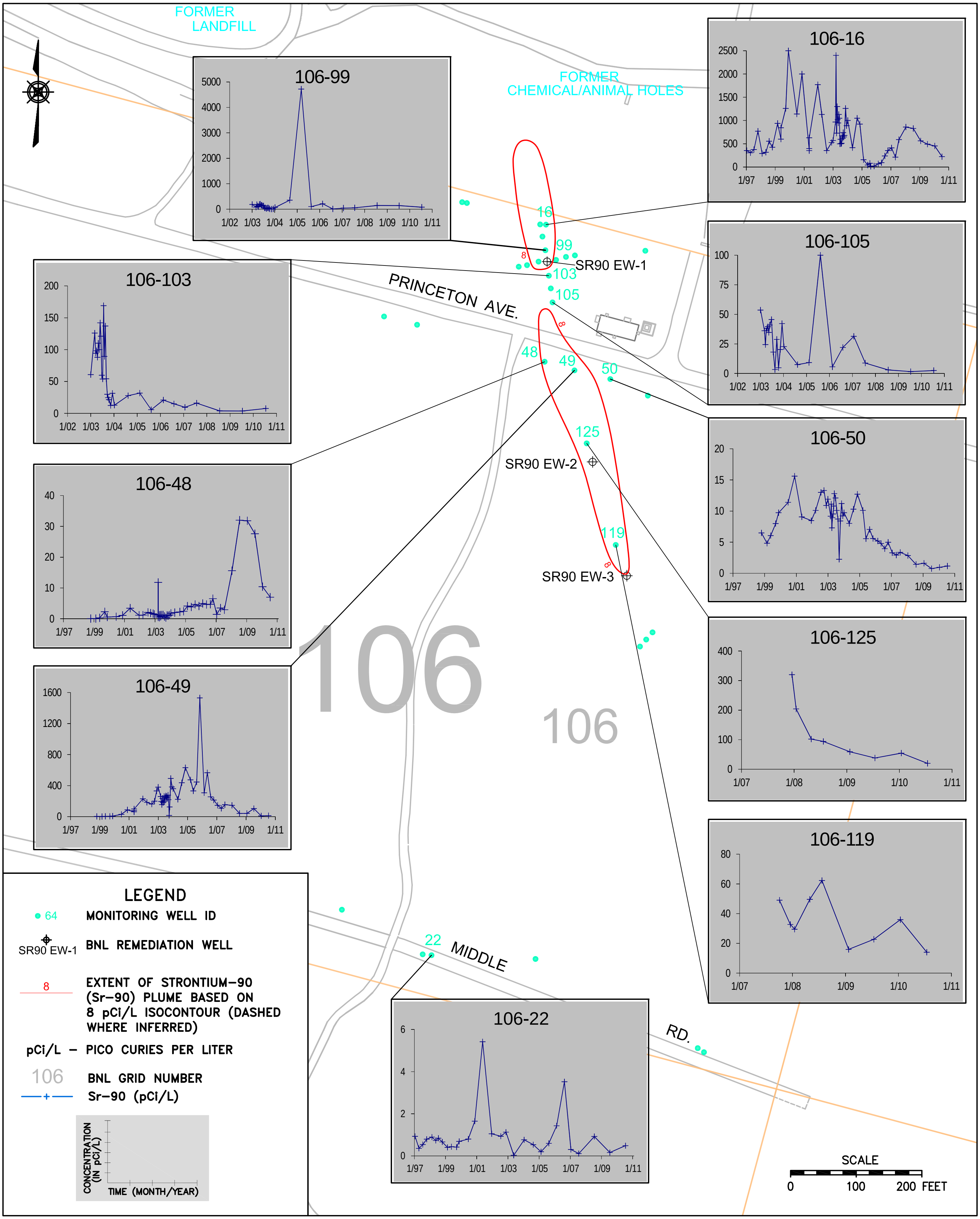
ENVIRONMENTAL
PROTECTION DIVISION

TITLE:

OU III BGRR/WCF
HISTORICAL Sr–90 TRENDS

2010 BNL FIVE–YEAR REVIEW

DWN: AJZ	VT: HZ.: –	DATE: 02/22/11	PROJECT NO.: –
CHKD: JEB	APPD: WRD	REV.: –	NOTES: –
FIGURE NO.:	6–9		



\\OERNT\GIS\GW_PROJECTS\Five Year Review – 2010\Fig_06-10 022311.DWG

BROOKHAVEN
NATIONAL LABORATORY

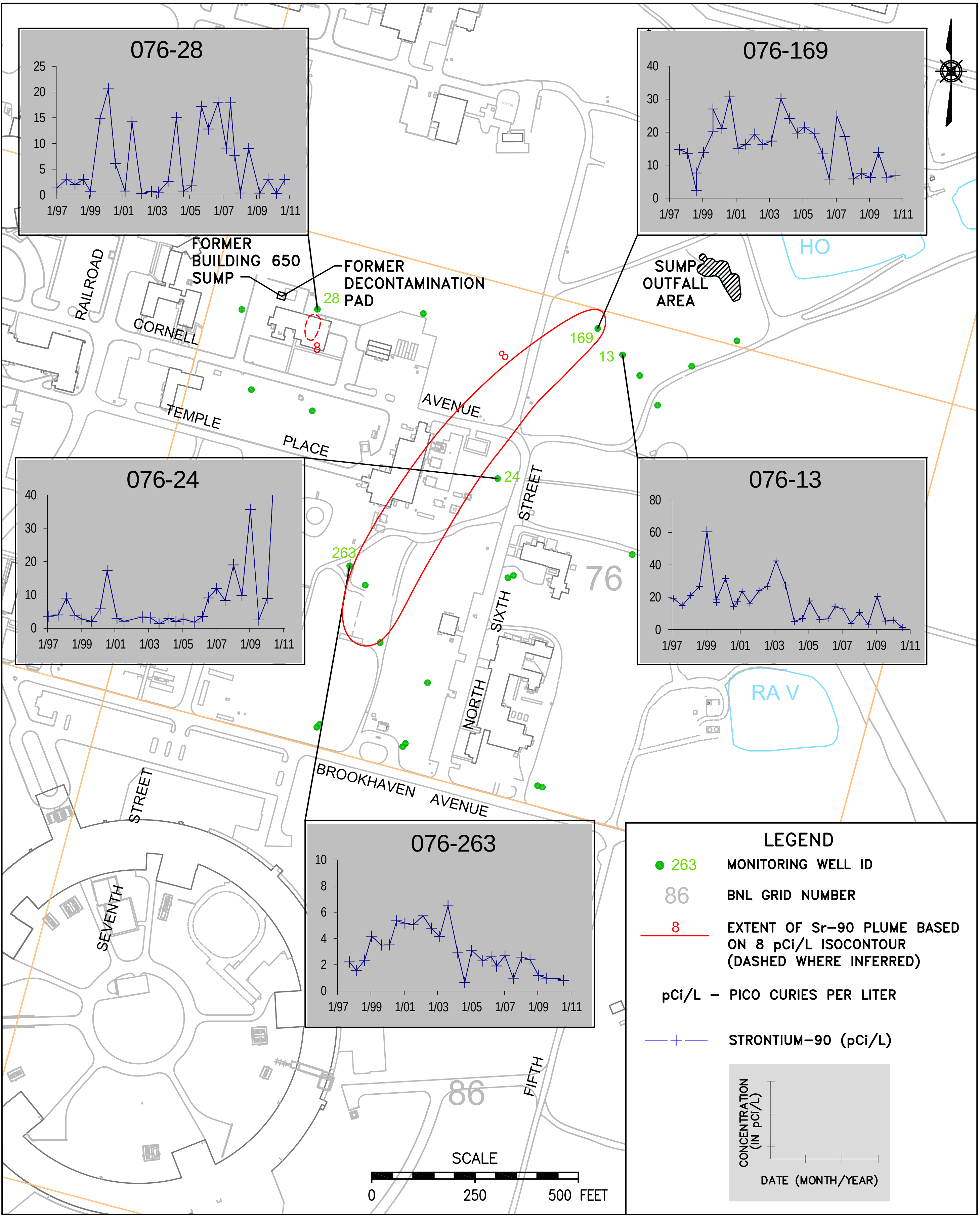
ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III CHEMICAL/ANIMAL HOLES HISTORICAL Sr−90 TRENDS

2010 BNL FIVE-YEAR REVIEW

DWN: DH
VT: HZ.: –
DATE: 02/23/11
PROJECT NO.: –
CHKD: JEB
APPD: WRD
REV.: –
NOTES: –
FIGURE NO.: 6−10



\\OERNT\GIS\GW_PROJECTS\Five Year Review – 2010\Fig_06-11 022311.DWG

BROOKHAVEN
NATIONAL LABORATORY

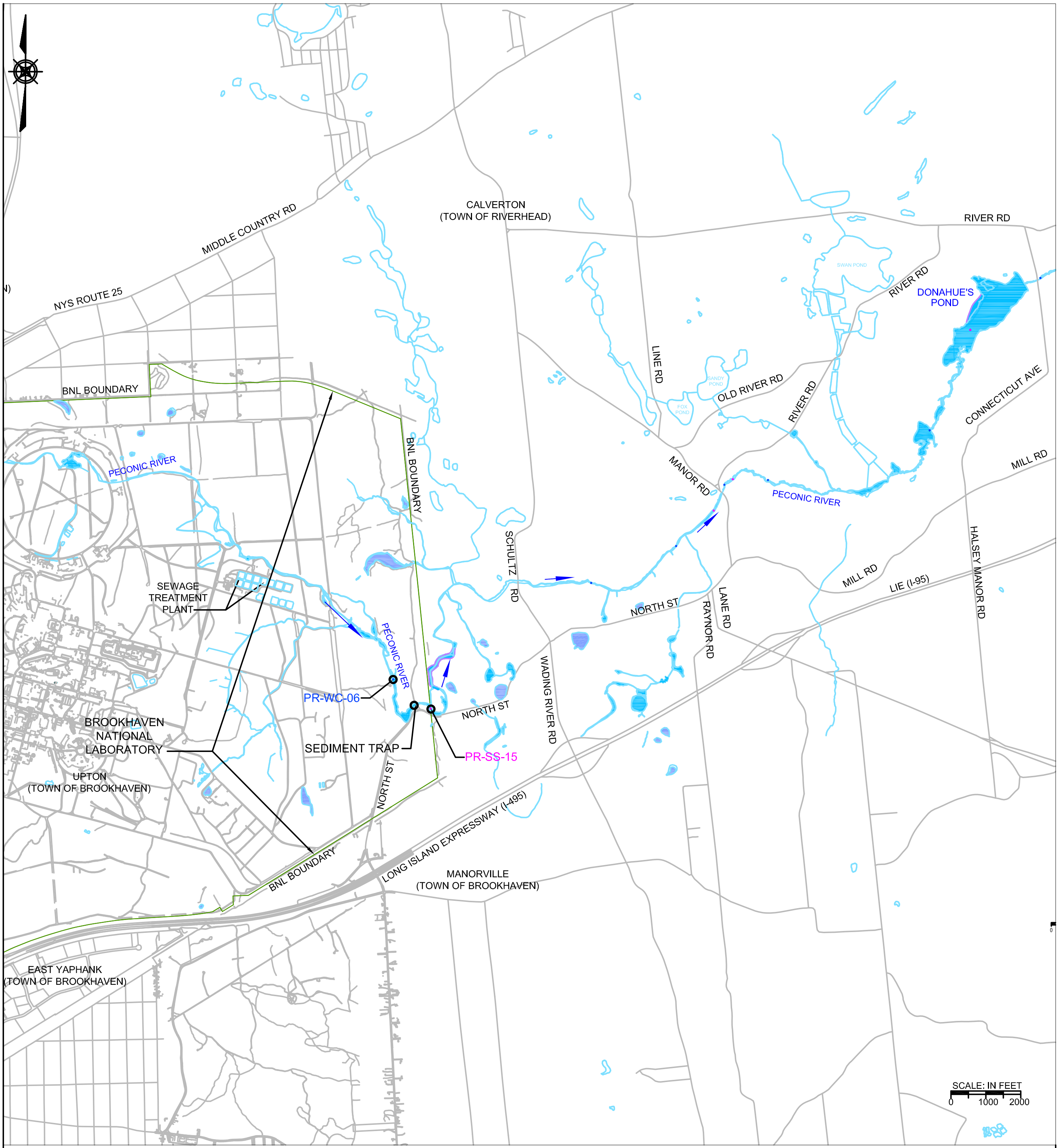
ENVIRONMENTAL
PROTECTION DIVISION

TITLE:

OU IV AOC 6
HISTORICAL Sr-90 TRENDS
2010 BNL FIVE-YEAR REVIEW

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
DH	–	02/23/11	–
CHKD:	APPD:	REV.:	NOTES:
JEB	WRD	–	–

FIGURE NO.: 6-11



\\OERNT\GIS\GW_PROJECTS\FIVE YEAR REVIEW\Fig_06-12 030211.dwg

LEGEND

🟦	PECONIC RIVER	PR-WC-06 ●	SURFACE WATER SAMPLING STATION ID
🟦	ISOLATED POND	PR-SS-15 ▲	SEDIMENT SAMPLING STATION ID
▨	MARSH AREAS	→	PECONIC RIVER FLOW DIRECTION

BROOKHAVEN
NATIONAL LABORATORY

ENVIRONMENTAL
PROTECTION DIVISION

TITLE:

PECONIC RIVER SEDIMENT TRAP AND SUPPLEMENTAL REMOVAL LOCATIONS

2010 BNL FIVE-YEAR REVIEW

DWN: AJZ	VT: HZ.: –	DATE: 03/02/11	PROJECT NO.: –
CHKD: WM	APPD: –	REV.: –	NOTES: –
FIGURE NO.: 6-12			

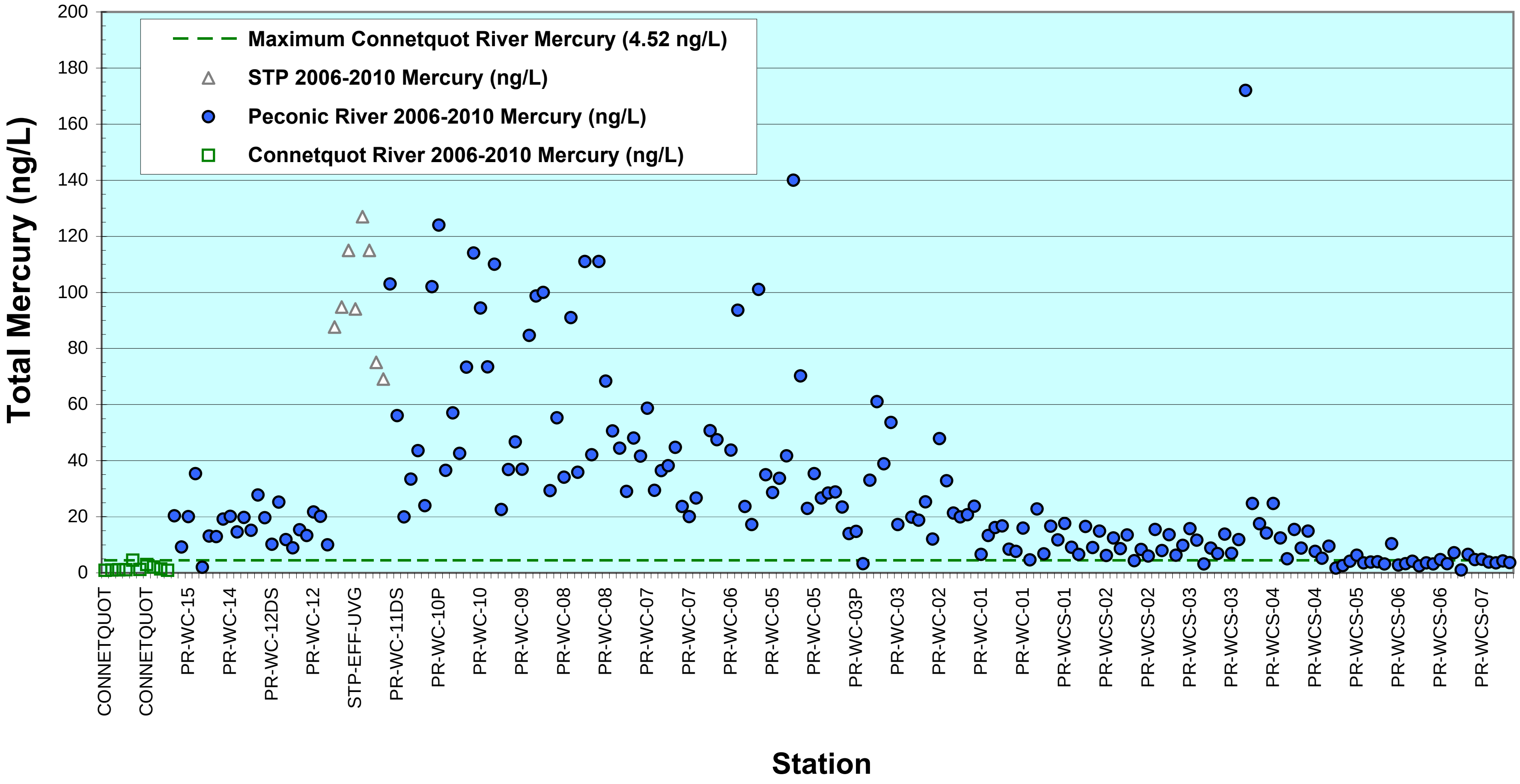
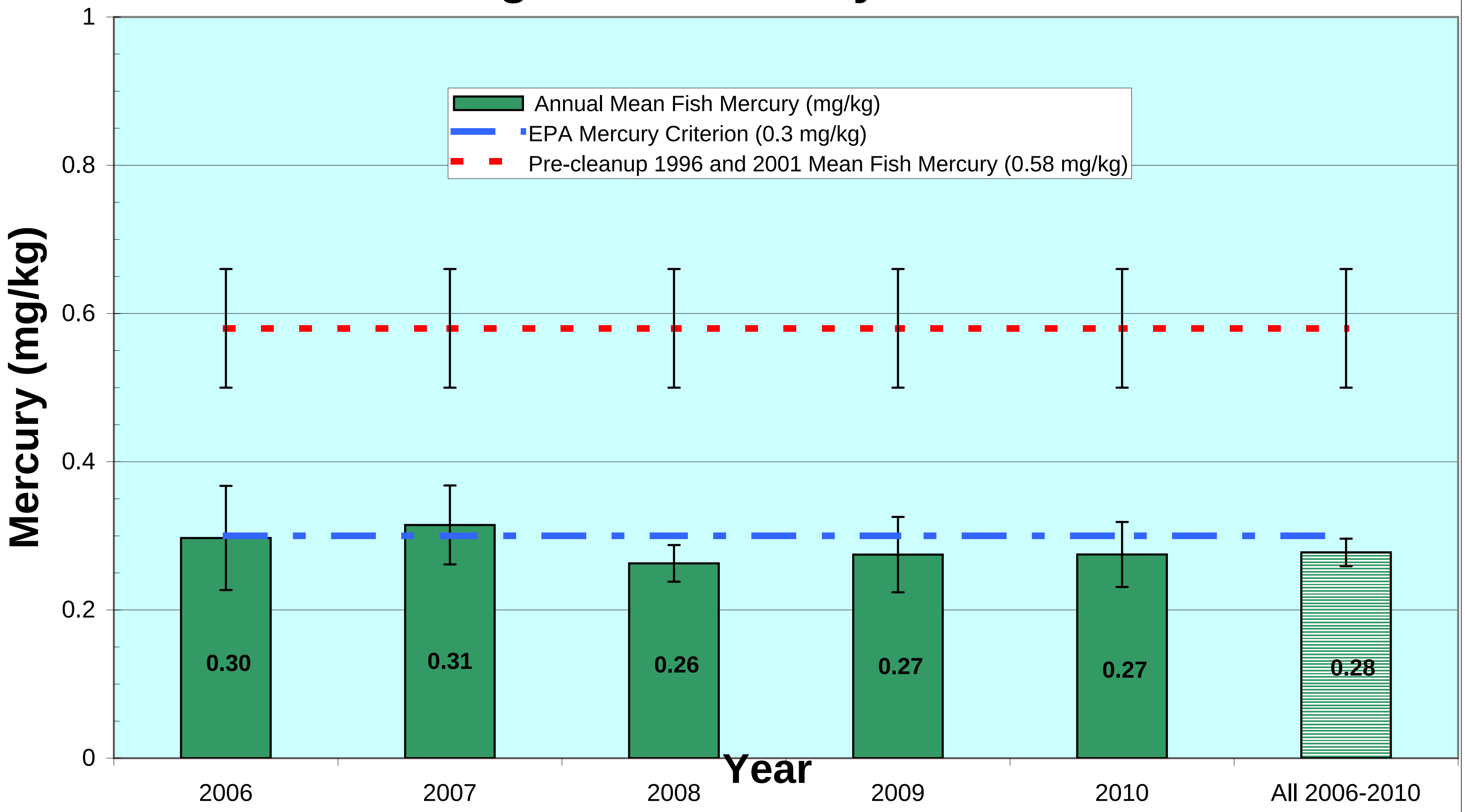


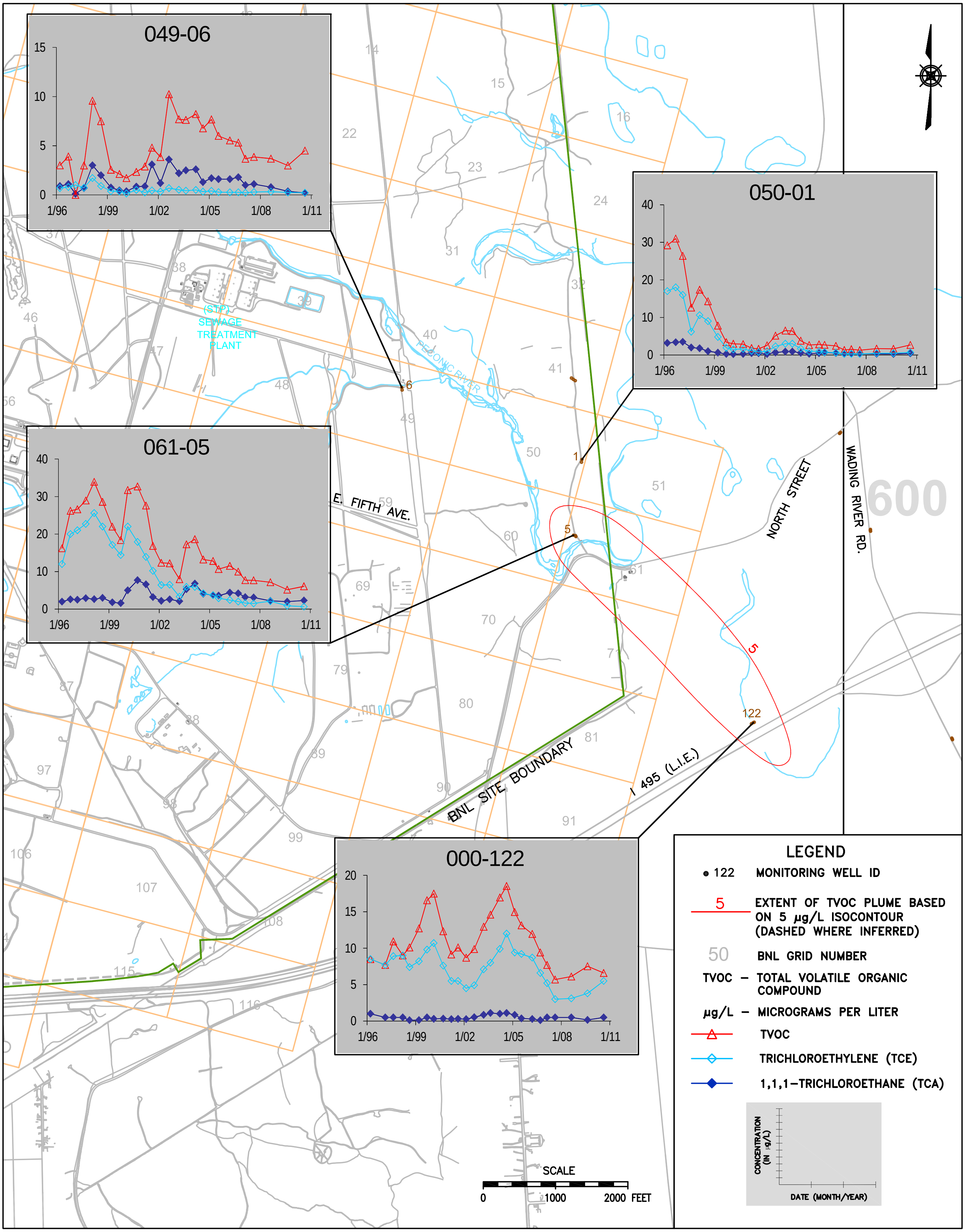
Figure 6-13 2006 - 2010 Peconic River and Connetquot River and 2007 - 2010 STP Mercury Concentrations

(Two values at PR-WC-06 and one value at PR-WC-03 are beyond the scale of this figure, 876 ng/L, 1,360 ng/L and 374 ng/L, respectively.)

Figure 6-14 2006 - 2010 Peconic River Average Fish Mercury Concentrations



Error bars represent the mean plus and minus the 95 percent confidence limits



\\OERNT\GIS\GW_PROJECTS\Five Year Review – 2010\Fig_06-15 022411.DWG

BROOKHAVEN
NATIONAL LABORATORY

ENVIRONMENTAL
PROTECTION DIVISION

TITLE:

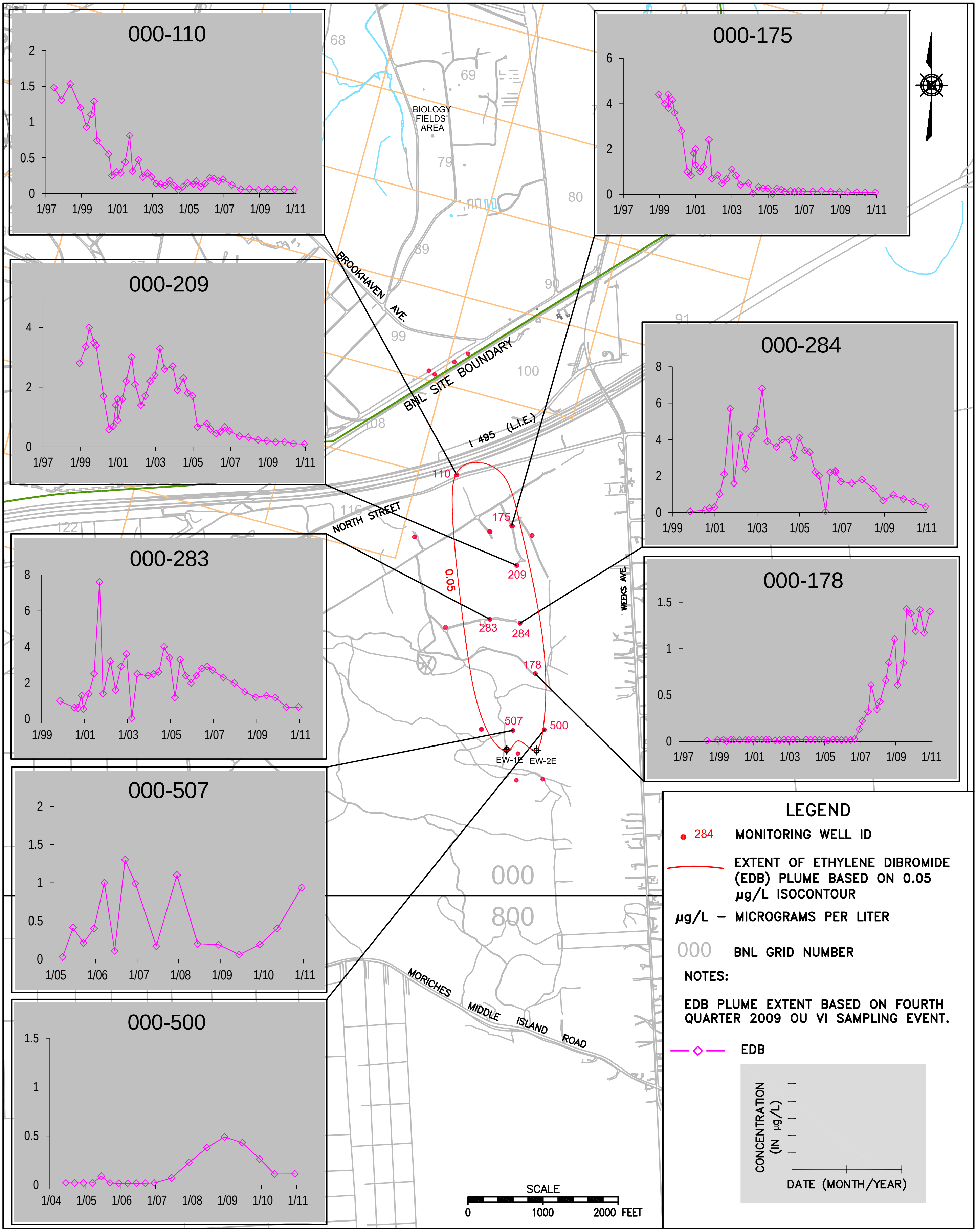
OU V SEWAGE TREATMENT PLANT HISTORICAL VOC TRENDS

2010 BNL FIVE–YEAR REVIEW

DWN: AJZ	VT: HZ.: –	DATE: 02/24/11	PROJECT NO.: –
CHKD: JEB	APPD: WRD	REV.: –	NOTES: –

FIGURE NO.: 6–15

\\OERNT\GIS\GW_PROJECTS\Five Year Review – 2010\Fig_06–16 022311.DWG



BROOKHAVEN
NATIONAL LABORATORY

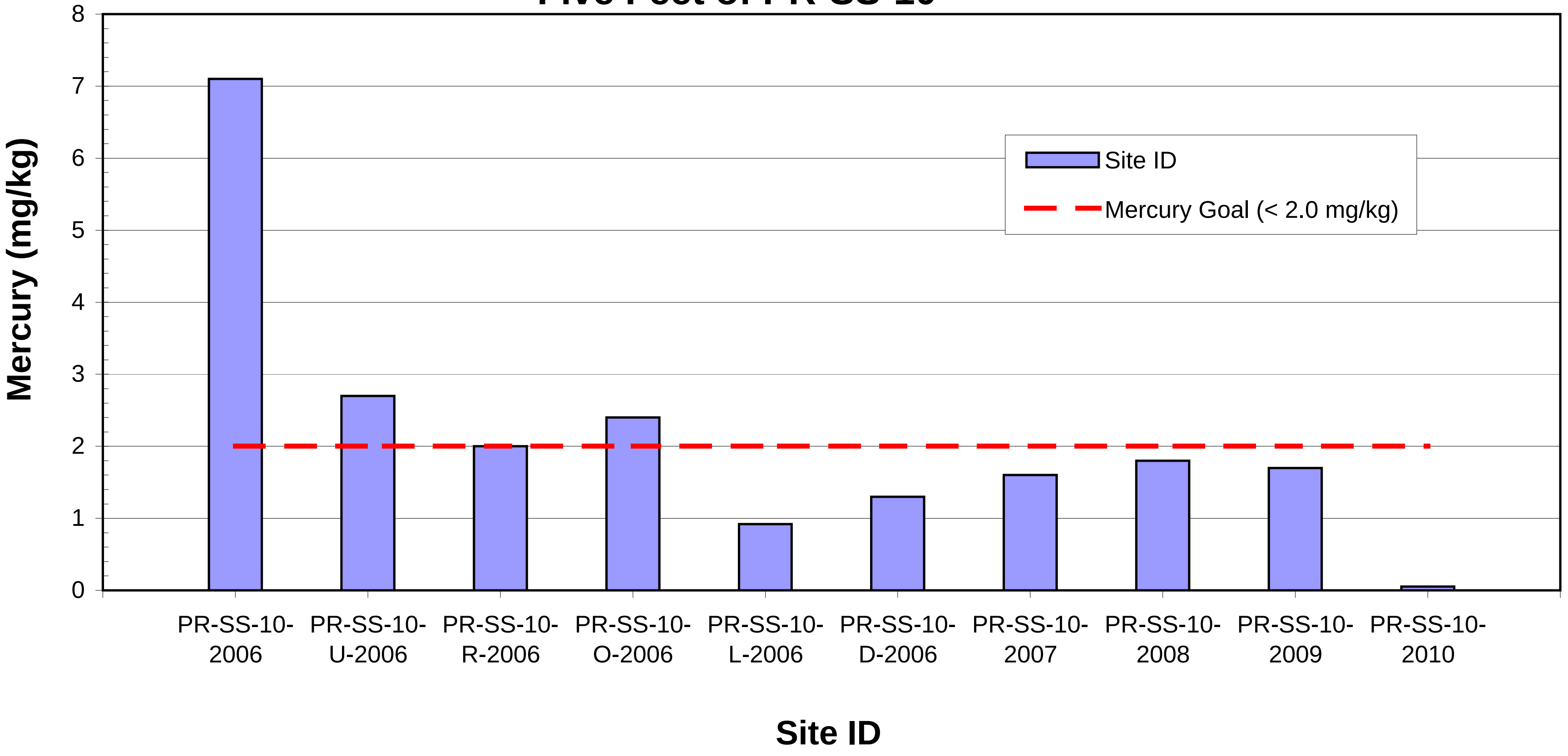
ENVIRONMENTAL
PROTECTION DIVISION

TITLE:

OU VI
HISTORICAL EDB TRENDS
2010 BNL FIVE–YEAR REVIEW

DWN: AJZ	VT:HZ.: –	DATE: 02/23/11	PROJECT NO.: –
CHKD: JEB	APPD: WRD	REV.: –	NOTES: –
FIGURE NO.: 6–16			

Figure 7-1 2006 - 2010 Sediment Mercury Data at or Within Five Feet of PR-SS-10



Attachment 1

Poll from September 9, 2010 BNL Community Advisory Council Meeting

Five-Year CERCLA Review

Community Advisory Council Input
September 9, 2010

September Meeting Survey

The Community Advisory Council members present at the September 9, 2010 meeting provided comments on the following questions. The comments are to serve as their input into the 2010 Five-Year Review. Additionally, some CAC members also provided written comments.

1. What is your overall impression of BNL's cleanup and do you feel well informed about the cleanup activities and progress?

Member Sprintzen: He is astounded at the care and attention of cleanup at the Peconic River. The Laboratory's effort to attend to and success at it is impressive.

Member Talbot commented on the responsiveness to questions and concerns of a diverse audience.

Member Shea: The quality of charts and graphs in presentations are helpful to us in understanding what's going on.

Member Sprintzen: The progress over the last 12 years has been a remarkable success and is rare. He said there has been a transformation of culture and the contribution of knowledgeable people shows that the Lab is very responsive to the concerns of the community. The Lab has responded constructively to our comments.

Member Henagan: He would add that the Lab is open and pro-active. He commended the Laboratory on being a good neighbor.

Member Chaudhry: The work the Lab is doing on cleanup and keeping the CAC informed is good, but he would like to see the sampling at some point to see the accuracy of the information.

Member Blumer: I am impressed with the speed and responsiveness of the Lab. She sees change due to the CAC's efforts.

Member Biss: Usually the follow-up is good, but sometimes it is missed. She asked what happened to the information on the HFBR. She suggested the Lab occasionally write a letter to the general public with updated information on different topics. Perhaps the Lab could submit articles to the newspapers to get information out to the public.

Member Esposito: Overall things have been very good, she feels well informed. Her organization was looking for cleanup of existing contamination, preventing future contamination, and changing the culture at the Lab. She feels all three have been accomplished. Culture change is the most important. She said always keep transparency and an engaged stakeholder, such as the CAC. She said you need to have checks and balances. Be vigilant.

Member Shea: I would like to follow up on the idea of keeping the public informed. She said broad communication with full disclosure builds confidence.

Member Sprintzen: It is very helpful to have Reed, as the facilitator, here to find common ground and articulate what is said.

Member Guthy agreed and said the CAC and the Lab have come so far.

2. Are there any specific aspects of the cleanup that you feel should be of particular focus during the review? (e.g. Records of Decision, cleanup goals, community input, etc.)

Member Esposito: The timelines should be expedited. Particularly the 50 and70 year timelines for both groundwater and soil remediation, when and where it can be expedited; it should be.

Member Talbot: Skip Medeiros said some places need to be remediated and they are using a new approach. It's important to pursue emerging technologies.

3. Do you feel confident in BNL and DOE's management of the long-term cleanup operations of the site?

Reed said this topic has been covered thoroughly already and asked if anyone had further comment.

4. Do you have any comments, suggestions, or recommendations regarding BNL/DOE's management and communications of the cleanup?

Member Esposito: Keep an educated stakeholder entity so you don't become complacent.

Member Heil: Continue to seek monetary support from Washington D.C. It is important to continue to fund the cleanup effort.

Member Talbot: There has been a nice transition of different Lab Directors. He said site level management is moving forward consistently.

Member Chaudhry: Some community members feel that BNL has spread contamination. He would like more detailed involvement so he would be in a better place to spread accurate information to the public. Perhaps more site visits to see the actual work being done.

Member Henagan: It is important to educate the public. Summer Sundays are great, but some avenues are being missed. Perhaps half hour science shows on TV to keep the public informed and push science education from BNL.

Member Blumer: She will send her responses through the mail. She said her experience has been that many things happen that are not coordinated. She was given a chart, but still couldn't figure out how decisions are made. She is an ecologist and feels that some of the decisions lack a certain amount of concern or knowledge of the environment.

Written Reponses

The following are written responses were received from CAC members on the following four questions:

1. What is your overall impression of BNL's cleanup and do you feel well informed about the cleanup activities and progress?

2. Are there any specific aspects of the cleanup that you feel should be of particular focus during the review: (e.g. Records of Decision, cleanup goals, community input, etc.)

3. Do you feel confident in BNL and DOE's management of the long-term cleanup operations for the site?

4. Do you have any comments, suggestions, or recommendations regarding BNL / DOE's management and communications of the cleanup?

Chris Birben
Colonial Woods / Whispering Pines

Positive, impressive, successful. Responsiveness to concerns and inquiries.

Timelines – is there anywhere that the goals / time frames of the cleanup that is still ongoing can be expedited.

Yes, how can BNL and DOE continue the funding to help with the long-term management of the clean up.

The onus is one me to absorb and digest information shared and presented to the CAC, as a representative of my organization I would have appreciated more time than two or three business days to solicit individual responses of my civic community for opinion responses. For example, the prior Five-Year survey possibly could have tracked back to those individuals. Also, the knowledgeable facilitator for the CAC meetings has been invaluable.

Rita Biss
Lake Panamoka Civic Association

The cleanup appears to be going quite well and information provided especially at the CAC meetings is good. One problem is that some seem to tall through the cracks, nothing is heard about the problem for several years.

One idea to cover the lack of information would be to have an annual summary of either the entire cleanup or completed work or a statement, e.g. the work has been performed and why. e.g. time required for radiation levels to be lowered by time.

A summary of problems, with or without solutions should be presented in the yearly summary.

Local newspapers would probably accept and publish a statement or article from BNL about progress and/or problems and/or new ideas in work at BNL. The summer schedule of summer tours was good. A short published article several times a year would keep the local community informed about BNL.

Iqbal Chaudhary
Science & Technology

I think BNL has done a very good job at clean up of various pollutants that resulted from its operation over the years past. With a slower start or insufficient attention in the beginning BNL became much more attentive and responsive to addressing the problem more systematically and more scientifically in accord with acceptable industrial practices. The progress has been accelerated with the availability of additional funding from the current administration. BNL has been doing as excellent job at keeping the CAC well informed on the progress and success of its cleanup operations.

Community input should be the most important aspect of the focus during the review. Whereas the majority of Long Island residents are now reasonably satisfied with the efforts and accomplishments of the Lab there still are people who harbor concerns at the long term impact of the pollutants that might have been left untreated or ignored so far.

Yes, I have no qualms with the ability and competence of the BNL in managing the long term cleanup operations and in fact I can vouch for it from my person perspective as a member of the CAC.

I find that BNL's communications on the clean up are very competent and efficient. Perhaps more opportunities for the CAC to conduct group site visits would enhance acceptance by the community of the results achieved and reported.

Adrienne Esposito
Citizens Campaign for the Environment

Yes, the CAC is well informed about the cleanup and progress. BNL cleanups are very comprehensive.

Yes, some of the times for remediation. Many clean up plans that are planned for between 50 – 70 years – I feel this is too long. Review of emerging technology for the various cleanups.

Yes, as long as there is a vibrant, educated CAC and community input process. Every system needs accountability. Transparency of the process is key to the success of effectively managing the long-term cleanup.

Don't get lazy or complacent. Provide informative, technical presentations to CAC and don't hold back.

Don Garber
Affiliated Brookhaven Civic Organizations

I think the cleanup is proceeding extremely well. Partly do to the infusion of extra stimulus funds but mainly due to excellent organization and commitment by the cleanup groups. The Lab management directors from Marburger to Chaudhari to Aronson have shown exemplary commitment to keep the CAC and others informed on the cleanup progress.

While the ROD and the Goals are largely behind us, future meetings should focus on how well the cleanup is progressing. Earlier meetings were a good balance as the CAC needed to be informed of the problems then have its input solicited.

I feel quite confident in the present BNL and DOE management. I hope that the present Lab management continues with adequate funding to meet our joint objectives.

I think the dialog is working well. I must point out that the Lab's providing the CAC with Reed Hodgin as a moderator has been quite pivotal to the smooth working of the CAC and therefore to the constructive dialog between the Lab and the community stakeholders.

Helga Guthy
Wading River Civic Association

We have been well informed. BNL has been very responsive to our concerns. The effort of the Lab to bring in people and cover subjects we have asked about has been extremely informative.

Nothing specific that I know of, just do the thorough jobs have done in the past.

Yes, everyone has gone to extremes to furnish information and done clean up of all contamination, throughout BNL, that the CAC has been concerned about.

Continue to include community concerns, and to clean up and inform us of what is happening at BNL in the future.

James Heil
Town of Brookhaven, Senior Representative

The cleanup appears to be well managed and on schedule. The CC is well informed on the progress of the cleanup.

Unanticipated events or procedures learned that could be used under similar circumstances at other Labs should be focused on as well as advances in technologies.

Yes, I feel confident in BNL and DOE's management.

I don't have any additional comments, suggestions, or recommendations.

Pat Henagan
Ridge Civic Association

I feel very informed on the cleanup. The Lab has been very forth coming on "blemishes" that it finds in the process.

Rate of progress towards the goals should be focused on.

Yes, with the current management. I do hope that future management teams continue this level of performance.

BNL has done an excellent job of keeping the CAC informed. It is disappointing that the Lab doesn't do more public communication via available media channels. Besides the newspapers, BNL PR dept should look at the possibility of either public access channels or News12 to do a weekly program.

Beth Motschenbacher
Long Island Pine Barrens Society

We have been asking for a very long time for a summary of how each clean-up component worked out relative to expectations, time, and expense. We don't think we know this at all.

Cleanup goals relative to projected and actual expenses should be focused on.

If BNL continues open communication and modifying its practices based on lessons learned from past mistakes then the prognosis for long-term cleanup looks good.

The Lab seems to be communicating well on current operations and advising the CAC of the rare problems that have cropped up. We think communications between the Lab and the community have steadily improved.

Arnie Peskin
Brookhaven Retired Employees Association

I have a positive feeling about both the cleanup and the Lab's attempt to keep the CAC informed.

In addition to the three mentioned above, perhaps a review of Lab programs to keep the community informed (community dialogue, not just community input).

I do, but recognize this can change each time there is a change in BNL or DOE management. Who is the custodian of the "institutional memory" of commitments?

I have no other comments or suggestions, other than what I have mentioned above.

David Sprintzen
Long Island Progressive Coalition

I think that BNL has done an exceptional job on informing and responding to community input and has addressed the cleanup with responsibility, attention to detail, and concerns for health and safety.

Goals and community input – in accord with technical information concerning environmental and health and safety concerns.

So long as current management and goals remain, the answer is yes.

It is important for BNL/ DOE to provide complete and timely information of problems and strategies to the members of the CAC.

Tom Talbot
Longwood Alliance

BNL provided numerous opportunities for CAC members to request and receive information, additionally, field trips and topic specific presentation were set up and well attended.

Goal management is the most effective means of evaluating many of the issues addressed in the cleanup. Oversight should also include emerging technologies that may benefit the cleanup

Yes, and hopefully financial constraints will not be an issue, or cause the Lab to forgo their true missions in order to fund the cleanup operations.

It is a good model of how to deal with a complex set of issues and to communicate with a diverse audience. It appears that BNL management/staff have successfully implemented a culture change which will endure.

No Name

BNL's cleanup has been vigorous, transparent, and targets stakeholder groups for input. Considerable progress has been made across-the-board.

An ongoing tally of the degree to which cleanup goals have been met would be most useful (particularly if made available online).

BNL has demonstrated its sincerity to best environmental practices and has gained the confidence of the many stakeholder groups involved in the CAC.

More on-site tours of cleanups and other items of environmental interest. And outreach to students (high school and colleges).

Attachment 2

2009 BNL Groundwater Status Report, BNL 2009 (CD Version)

(To be included in public availability version)

Attachment 3

Inspection Checklists

BNL Five-Year Review Site Inspection Checklist

I. SITE INFORMATION

Site name: Brookhaven National Laboratory	**Date(s) of inspection:** 3/30/10 through 7/12/10
Location and Region: Upton, NY, EPA Region 2	**EPA ID:** NY7890008975
Agency, office, or company leading the five-year review: Brookhaven Science Associates (BSA) for the U.S. Department of Energy (DOE)	**Weather/temperature:** NA

Remedy Includes: (Check all that apply)

☒Landfill cover/containment	☒ Monitored natural attenuation
☒ Access controls	☒ Groundwater containment
☒ Institutional controls	☐ Vertical barrier walls
☒ Groundwater pump and treatment	
☐ Surface water collection and treatment	
☐ Other____	

Attachments: ☒ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _ Bill Dorsch, LTRA Manager_
Interviewed ☒ at site ☒ at office ☐ by phone Phone no. _344-5186
Problems, suggestions; ☐ Report attached _Work with on a daily basis and discuss issues weekly. ___

2. **O&M staff** Vinnie Racaniello, Eric Kramer, Adrian Steinhauff, Project Manager and Field Engineers
Interviewed ☒ at site ☒ at office ☐ by phone Phone no. 344-5436, 8226, 2363______________
Problems, suggestions; ☐ Report attached Work with on a daily basis and discuss issues weekly.____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency ___EPA, DEC, SCDHS, DOE _________________________
Contact ____________________________ __________________ ________ ____________
Name Title Date Phone no.
Problems; suggestions; ☒ Report attached See interview records.
____

Agency ____________________________
Contact ____________________________ __________________ ________ ____________
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached ____
____

4. **Other interviews** (optional) ☐ Report attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**
☒ O&M manual ☒ Readily available ☒ Up to date ☐ N/A
☒ As-built drawings ☒ Readily available ☒ Up to date ☐ N/A
☐ Maintenance logs ☐ Readily available ☐ Up to date ☐ N/A
Remarks: All O&M Manuals have been updated and are available on the website. The as-built drawings are available through Facility & Operations database.

2. **Site-Specific Health and Safety Plan** ☒ Readily available ☒ Up to date ☐ N/A
☒ Contingency plan/emergency response plan ☒ Readily available ☒ Up to date ☐ N/A
Remarks: Each project has a H&S Plan and Work Permit specific to that job. The operating groundwater treatment systems have a contingency/emergency plan in their O&M Manuals.
____

3. **O&M and OSHA Training Records** ☒ Readily available ☐ Up to date N/A
Remarks _Worker training records are available on the BNL training website database. __

4. **Permits and Service Agreements**
☒ Air discharge permit ☒ Readily available ☒ Up to date ☐ N/A
☒ Effluent discharge ☒ Readily available ☒ Up to date ☐ N/A
☐ Waste disposal, POTW ☐ Readily available ☐ Up to date ☐ N/A
☒ Other permits: Peconic ☒ Readily available ☒ Up to date ☐ N/A
Remarks: DEC air and SPDES equivalency permits in place for all treatment systems, as appropriate. Peconic River On-site and Off-site Supplemental Sediment Removal permit is in place. ____

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ☒ N/A
Remarks: Passive gas venting only. ____

6. **Groundwater Monitoring Records** ☒ Readily available ☒ Up to date ☐ N/A
Remarks: Groundwater monitoring data is made available via the Quarterly System Operations Reports, as well as the Annual Groundwater Status Report. ________________

7. **Discharge Compliance Records**
☒ Air ☒ Readily available ☒ Up to date ☐ N/A
☒ Water (effluent) ☒ Readily available ☒ Up to date ☐ N/A
Remarks: Discharge Monitoring Reports (DMRs) for the treatment systems with SPDES equivalency permits are issued monthly to the DEC. Air compliance records are documented in the Annual Groundwater Status Reports. _________________________________

8. **Daily Access/Security Logs** ☒ Readily available ☐ Up to date ☐ N/A
Remarks_Daily operating data sheets for the groundwater systems are available at the treatment building and the Project files.

9. **Comments** ____
____
____

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☒ Contractor for Federal Facility
☐ Other: Responsibility for managing BNL's Long Term Response Actions lies with the Environmental Protection Division's (EPD) Groundwater Protection Group (GPG). ___

2. **O&M Cost Records**

☒ Readily available ☒ Up to date
☒ Funding mechanism/agreement in place
Original O&M cost estimate____________________ ☐ Breakdown attached

Total annual cost by year for review period if available

From	10/04	To	9/05	Avg. Annual of $246K	☒ Breakdown attached
	Date		Date	Total cost	
From	10/05	To	9/06	Avg. Annual of $228K	☒ Breakdown attached
	Date		Date	Total cost	
From	10/06	To	9/07	Avg. Annual of $211K	☒ Breakdown attached
	Date		Date	Total cost	
From	10/07	To	9/08	Avg. Annual of $203K	☒ Breakdown attached
	Date		Date	Total cost	
From	10/08	To	9/09	Avg. Annual of $204K	☒ Breakdown attached
	Date		Date	Total cost	

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: No unusually high O&M costs identified. FY05 was the first full year of operation for the five treatment systems beyond the BNL property. The annual costs for each system from FY2005 through FY2009 is identified in the Five-Year Review.

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☐ N/A
Remarks: See Current Landfill inspection forms for needed repair to gate. _

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks: Identification signs are in place for all of the on-site and off-site groundwater treatment systems. DOE notification signs are in place for all treatment facilities located beyond BNL's property boundary. There are BNL security personnel at the site 24 hours per day. For the systems located beyond the BNL boundaries, security cameras are present that communicate with BNL's security personnel. Restricted use signs are posted at former soil cleanup areas including the Former Hazardous Waste Management Facility, former Meadow Marsh, Landfills, Ash Pit, former Chemical Holes, Bldg. 96, Bldg. 650 Sump Outfall, and Bldg. 811. ______________________________

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ☒ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by): Routine walkdown inspections of landfills, former soil cleanup areas, and groundwater treatment systems.
____

Frequency: Varies from almost daily for treatment systems, monthly for landfills, semi-annual former soil cleanup araes.
____

Responsible party/agency: BSA under contract with DOE.
____

Contact:

William Dorsch	BSA GPG Manager	3/21/05	(631) 344-5186
Gail Penny	DOE Project Manager	3/21/05	(631) 344-4363
Name	Title	Date	Phone no.

Reporting is up-to-date ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ☒ Yes ☐No ☐ N/A

Specific requirements in deed or decision documents have been met ☒ Yes ☐ No ☐ N/A
Violations have been reported ☐ Yes ☒ No ☐ N/A
Other problems or suggestions: ☐Report attached
Remarks: There are seven access agreements in place among BSA/DOE and various property owners to allow for operation of BNL's groundwater remediation systems for plumes that have migrated beyond the BNL property. Each agreement has terms and conditions that must be adhered to. A license agreement is also in place among BSA/BHSO/Suffolk County for the supplemental sediment cleanup for the Peconic River in 2010/2011.___________________________________

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks: The Land Use Controls Management Plan and institutional controls website and fact sheets continue to be updated, as needed to reflect the most recent IC's for each project. ___

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident
Remarks_There has been some vandalism in the past at some of the treatment systems located beyond the BNL property. However, additional precautions have been implemented such as security cameras, motion detectors, and fencing to help minimize the potential risk. ____________

2. **Land use changes on site** ☒ N/A
Remarks: None____

3. **Land use changes off site** ☒ N/A
Remarks: None____

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks____

B. Other Site Conditions

Remarks: ____

VII. SOIL CLEANUP REMEDIES ☒ Applicable ☐ N/A

A. Project OU I AOC 2F Ash Pit 6/24/10

1. **Soil Excavation Complete** ☒ Yes ☐ No

Remarks ____

2. **S&M Documents**

☒ S&M Plan ☒ Readily available ☐ Up to date ☐ N/A
☒ Completion/Closeout Report ☒ Readily available ☒ Up to date ☐ N/A
☐ Maintenance logs ☐ Readily available ☐ Up to date ☒ N/A

Remarks: Final Closeout Report for the Ash Pit OU I AOC 2F, dated 2/5/04. Section 4.0 of the Closeout Report identifies LTRA requirements (i.e., annual inspection). _

3. **Settlement** (Low spots) ☒ Location shown on site map ☒ Settlement not evident

Areal extent ______________ Depth____________

Remarks: None

____

4. **Erosion** ☒ Location shown on site map ☒ Erosion not evident

Areal extent______________ Depth____________

Remarks: None.

____

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☒ No signs of stress

☒ Trees/Shrubs (indicate size and locations on a diagram)

Remarks: Trees surround the pit area. Excellent native grass growth.

____

6. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident

☐ Wet areas ☐ Location shown on site map Areal extent______________
☐ Ponding ☐ Location shown on site map Areal extent______________
☐ Seeps ☐ Location shown on site map Areal extent______________
☐ Soft subgrade ☐ Location shown on site map Areal extent______________

Remarks: None.

____

7. **Monitoring Wells** (within the excavated area)

☒ Properly secured/locked ☒ Functioning ☐ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A

Remarks____

____

8. **Other Site Conditions**

Remarks: Inspection attendees include W. Dorsch, R. Howe, K. Conkling, D. Hanley. ____

VII. SOIL CLEANUP REMEDIES ☒ Applicable ☐ N/A

A. Project OU I AOC 8 Meadow Marsh 6/28/10

1. **Soil Excavation Complete** ☒ Yes ☐ No

Remarks

2. **S&M Documents**

☒ S&M Plan ☒ Readily available ☐ Up to date ☐ N/A
☒ Completion/Closeout Report ☒ Readily available ☒ Up to date ☐ N/A
☐ Maintenance logs ☐ Readily available ☐ Up to date ☒ N/A

Remarks: Final Closeout Report for the Meadow Marsh OU I AOC 8, dated 2/6/04. Section 4.0 of the Closeout Report identifies LTRA requirements (i.e., ecological monitoring and inspection for Tiger Salamanders). Institutional controls are also identified in the Report.

3. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident

Areal extent______________ Depth____________

Remarks

4. **Erosion** ☐ Location shown on site map ☒ Erosion not evident

Areal extent______________ Depth____________

Remarks

5. **Vegetative Cover** ☐ Grass ☐ Cover properly established ☒ No signs of stress

G Trees/Shrubs (indicate size and locations on a diagram)

Remarks: Native grasses planted adjacent to the pond.

6. **Wet Areas/Water Damage** ☐ Wet areas/water damage not evident

☐ Wet areas ☐ Location shown on site map Areal extent______________
☒ Ponding ☐ Location shown on site map Areal extent______________
☐ Seeps ☐ Location shown on site map Areal extent______________
☐ Soft subgrade ☐ Location shown on site map Areal extent______________

Remarks: The remediated area is a pond for the Tiger Salamanders.

7. **Monitoring Wells** (within the excavated area)

☒ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A

Remarks

8. **Other Site Conditions**

Remarks: Inspection attendees include R. Howe, D. Hanley.

VII. SOIL CLEANUP REMEDIES ☒ Applicable ☐ N/A

A. Project OU I AOC 6 Bldg. 650 Sump Outfall 6/29/10

1. **Soil Excavation Complete** ☒ Yes ☐ No
Remarks ______________________________

2. **S&M Documents**
☒ S&M Plan ☒ Readily available ☐ Up to date ☐ N/A
☒ Completion/Closeout Report ☒ Readily available ☐ Up to date ☐ N/A
☐ Maintenance logs ☐ Readily available ☐ Up to date ☒ N/A
Remarks: Draft Final Closeout Report for AOC 6 Bldg. 650 Sump and Sump Outfall, dated 1/02.

3. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
Areal extent______________ Depth____________
Remarks: The entire area is graded and a drainage swale exists that routes surface runoff to the ponded sump. The pond has been staying wet year round.

4. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
Areal extent______________ Depth____________
Remarks: ______________________________

5. **Vegetative Cover** ☒ Grass ☐ Cover properly established ☒ No signs of stress
☒ Trees/Shrubs (indicate size and locations on a diagram)
Remarks: Some trees surround the sump. Good native grass cover.

6. **Wet Areas/Water Damage** G Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent______________
☒ Ponding ☐ Location shown on site map Areal extent______________
☐ Seeps ☐ Location shown on site map Areal extent______________
☐ Soft subgrade ☐ Location shown on site map Areal extent______________
Remarks: Pond is Tiger Salamander habitat

7. **Monitoring Wells** (within the excavated area)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks:

8. **Other Site Conditions**
Remarks: Inspection attendees include W. Dorsch, V. Racaniello, R. Howe. Replace institutional control sign at pond. Fence partially surrounds the former sump outfall (no restrictions for entering area).

VII. SOIL CLEANUP REMEDIES ☒ Applicable ☐ N/A

A. Project OU I AOC 16S Landscape Soil Areas 6/22/10

1. **Soil Excavation Complete** ☒ Yes ☐ No
Remarks ______

2. **S&M Documents**
☒ S&M Plan ☒ Readily available ☐ Up to date ☐ N/A
☒ Completion/Closeout Report ☒ Readily available ☒ Up to date ☐ N/A
☐ Maintenance logs ☐ Readily available ☐ Up to date ☒ N/A
Remarks: Final Closeout Report for AOC 16 Landscape Soils, dated 4/10/01.

3. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
Areal extent______ Depth______
Remarks______

4. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
Areal extent______ Depth______
Remarks______

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☒ No signs of stress
G Trees/Shrubs (indicate size and locations on a diagram)
Remarks______

6. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent______
☐ Ponding ☐ Location shown on site map Areal extent______
☐ Seeps ☐ Location shown on site map Areal extent______
☐ Soft subgrade ☐ Location shown on site map Areal extent______
Remarks______

7. **Monitoring Wells** (within the excavated area)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks______

8. **Other Site Conditions**

Remarks: Inspection attendees include W. Dorsch, R. Howe, K. Conkling, D. Hanley.
Due to the construction of the Interdisciplinary Science Building (ISB), landscape soil from the Bldg. 355 area was excavated in March 2010 and transferred to the former HWMF to be used as fill (per attached ISB Letter to Regs 11/10/09). Three confirmatory soil samples identified remaining Cs-137 concentrations below 0.5 pCi/g. Recommendations: Update the Landscape Soil LUIC Factsheet to include that the Bldg. 355 soils were removed and confirmatory samples obtained. The area is now the location of the ISB construction site. No further inspections are necessary.

Landscape Soil From Bldg. 355

	
3/4/10 – Building 355 excavated landscape soil area at ISB construction site	3/2/10 – Excavated landscape soil transferred to former hazardous waste management facility for use as fill

VII. SOIL CLEANUP REMEDIES ☒ Applicable ☐ N/A

A. Project OU I AOC 1 Hazardous Waste Management Facility (HWMF) 6/28/10__________

1. **Soil Excavation Complete** ☒ Yes ☐ No
Remarks:

2. **S&M Documents**
☒ S&M Plan ☒ Readily available ☐ Up to date ☐ N/A
☒ Completion/Closeout Report ☒ Readily available ☒ Up to date ☐ N/A
☐ Maintenance logs ☐ Readily available ☐ Up to date ☒ N/A
Remarks: The OU I Soils and OU V Long-Term Monitoring and Maintenance Plan, dated May 2006. The Final Closeout Report for the Former Hazardous Waste Management Facility, dated 9/29/05.

3. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
Areal extent______________ Depth____________
Remarks:

4. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
Areal extent______________ Depth____________
Remarks: __

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☐ No signs of stress
☒ Trees/Shrubs (indicate size and locations on a diagram)
Remarks: Some trees remain.

6. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident
☒ Wet areas ☐ Location shown on site map Areal extent_small_________
☐ Ponding ☐ Location shown on site map Areal extent______________
☐ Seeps ☐ Location shown on site map Areal extent______________
☐ Soft subgrade ☐ Location shown on site map Areal extent______________
Remarks: Two small slightly wet areas in yard. Not significant since vegetation is well established. Backfill was added to these lower areas from the Bldg. 355 landscape soils (see Landscape Soil inspection). The wetland area immediately to the northwest of the FHWMF was slightly wet. _____

7. **Monitoring Wells** (within the excavated area)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks:

8. **Other Site Conditions**

Remarks: Inspection attendees include R. Howe, D. Hanley.
BNL RadCon completed the annual survey of the fixed contamination on several of the concrete foundations 6/15/10. No loose contamination detected. An Environmental Restoration Project (ERP) Radioactive Material Storage Area is located just outside the main gate and the postings extend slightly into the FHWMF. ERP to remove materials from the Waste Loading Area and fence and piping debris just outside the FHWMF yard. Following completion of ERP reactor waste shipping, perform Exit Readiness Evaluation for transfer of ownership to BNL Environmental Protection Division. Recommendation: Update LUIC Factsheet to reflect the identification in 2009 of the fixed contamination on five of the concrete foundations. They are rountine inspected and monitored by BNL and there should be no disturbance op these areas without BNL RadCon notification.

VII. SOIL CLEANUP REMEDIES ☒ Applicable ☐ N/A

A. Project OU V AOC 30 Peconic River 7/12/10

1. **Soil Excavation Complete** ☒ Yes ☐ No

Remarks: The original 2004/2005 is complete, however, procurement is underway to perform supplemental sediment remediation of three small areas in 2010. ____________________

2. **S&M Documents**
☒ S&M Plan ☒ Readily available ☐ Up to date ☐ N/A
☒ Completion/Closeout Report ☒ Readily available ☒ Up to date ☐ N/A
☐ Maintenance logs ☐ Readily available ☐ Up to date ☒ N/A
Remarks: The OU I Soils and OU V Long-Term Monitoring and Maintenance Plan, dated May 2006. Surface water, sediment, and fish monitoring requirements are identified in this Plan.

Final Closeout Report for Peconic River Remediation Phases 1 and 2, 8/25/05.

3. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
Areal extent_______________ Depth_____________
Remarks: __________

4. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
Areal extent_______________ Depth_____________
Remarks____
____

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☒ No signs of stress
☒ Trees/Shrubs (indicate size and locations on a diagram)
Remarks:

6. **Wet Areas/Water Damage** ☐ Wet areas/water damage not evident
☒ Wet areas ☐ Location shown on site map Areal extent_______________
☒ Ponding ☐ Location shown on site map Areal extent_______________
☒ Seeps ☐ Location shown on site map Areal extent_______________
☒ Soft subgrade ☐ Location shown on site map Areal extent_______________
Remarks: This is all indicitative of the River and wetland environment.

7. **Monitoring Wells** (within the excavated area)
☒ Properly secured/locked ☒ Functioning ☐ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks: Most wells are in good condition.

8. **Other Site Conditions**

Remarks: Inspection attendees include T. Green, R. Howe, W. Dorsch, D. Hanley.

VII. SOIL CLEANUP REMEDIES ☒ Applicable ☐ N/A

A. Project OU I AOC 10 Building 811 UST and Soils 6/29/10________________________

1. **Soil Excavation Complete** ☒ Yes ☐ No
Remarks: Excavation complete in 2005.
____

2. **S&M Documents**
☒ S&M Plan ☒ Readily available ☐ Up to date ☐ N/A
☒ Completion/Closeout Report ☒ Readily available ☒ Up to date ☐ N/A
☐ Maintenance logs ☐ Readily available ☐ Up to date ☒ N/A
Remarks: Final Closeout Report for AOC 10 Waste Concentration Facility, 9/05.
The OU I Soils and OU V Long-Term Monitoring and Maintenance Plan, dated May 2006.

3. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
Areal extent_______________ Depth_____________
Remarks: Excavation and restoration is complete.
____

4. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
Areal extent_______________ Depth_____________
Remarks: ___________________
____

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☒ No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram)
Remarks: Native grasses established. _____________

6. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent_______________
☐ Ponding ☐ Location shown on site map Areal extent_______________
☐ Seeps ☐ Location shown on site map Areal extent_______________
☐ Soft subgrade ☐ Location shown on site map Areal extent_______________
Remarks____
____

7. **Monitoring Wells** (within the excavated area)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☒ Needs Maintenance ☐ N/A
Remarks: All of the BNL monitoring wells are secured and locked. Cracked well casing for flush mount monitoring well 065-161 awaiting repairs once AB waste line remediation project is complete.

8. **Other Site Conditions**
Remarks: Inspection attendees include W. Dorsch, V. Racaniello, R. Howe.

VII. SOIL CLEANUP REMEDIES ☒ Applicable ☐ N/A

A. Project OU III AOC 26B Building 96 7/7/10______________________

1. **Soil Excavation Complete** ☒ Yes ☐ No

Remarks: PCB soil excavation complete in 2005. Planning is underway for the excavation of a localized area of high concentrations of PCE in soil that is scheduled to be excavated in August 2010.

2. **S&M Documents**

☒ S&M Plan	☒ Readily available	☐ Up to date	☐ N/A
☒ Completion/Closeout Report	☒ Readily available	☒ Up to date	☐ N/A
☐ Maintenance logs	☐ Readily available	☐ Up to date	☒ N/A

Remarks: OU III Building 96 PCB Soil (AOC 26B) Excavation Closeout Report, 3/05.

The OU I Soils and OU V Long-Term Monitoring and Maintenance Plan, dated May 2006.

3. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident

Areal extent______________ Depth____________

Remarks: Excavation of PCB soils is complete.

4. **Erosion** ☐ Location shown on site map ☒ Erosion not evident

Areal extent______________ Depth____________

Remarks: BNL Facility and Operations cleaned-out vegetation to adjacent culvert that is covered with asphalt, since it is impeding flow to Recharge Basin HS.________________________

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☒ No signs of stress

☐ Trees/Shrubs (indicate size and locations on a diagram)

Remarks: Native grasses established. ____________

6. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident

☐ Wet areas	☐ Location shown on site map	Areal extent______________
☐ Ponding	☐ Location shown on site map	Areal extent______________
☐ Seeps	☐ Location shown on site map	Areal extent______________
☐ Soft subgrade	☐ Location shown on site map	Areal extent______________

Remarks____

7. **Monitoring Wells** (within the excavated area)

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☒ Needs Maintenance ☐ N/A

Remarks: All of the BNL monitoring wells are secured and locked. Cracked well casing for flush mount monitoring well 065-161 awaiting repairs once AB waste line remediation project is complete.

8. **Other Site Conditions**

Remarks: Plastic cover over PCE-contaminated soils in good condition.
Inspection attendees include R. Howe.

VII. SOIL CLEANUP REMEDIES ☒ Applicable ☐ N/A

A. Project OU I AOC 2B,C Chemical/Animal/Glass Holes 6/21/10________________________

1. **Soil Excavation Complete** ☒ Yes ☐ No
Remarks: Soil excavation complete in 2005.

2. **S&M Documents**
☒ S&M Plan ☒ Readily available ☐ Up to date ☐ N/A
☒ Completion/Closeout Report ☒ Readily available ☒ Up to date ☐ N/A
☐ Maintenance logs ☐ Readily available ☐ Up to date ☒ N/A
Remarks: Animal/Chemical Pits and Glass Holes Remedial Action Closure Report Addendum, 9/05.
The OU I Soils and OU V Long-Term Monitoring and Maintenance Plan, dated May 2006.

3. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident
Areal extent______________ Depth____________
Remarks: None.
____

4. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
Areal extent______________ Depth_<1 foot___________
Remarks: BNL Facility and Operations to repair the one erosional area and seed.__________

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established ☐ No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram)
Remarks: Native grasses established. ____________

6. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent______________
☐ Ponding ☐ Location shown on site map Areal extent______________
☐ Seeps ☐ Location shown on site map Areal extent______________
☐ Soft subgrade ☐ Location shown on site map Areal extent______________
Remarks____
____

7. **Monitoring Wells** (within the excavated area)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks: None.

8. **Other Site Conditions**
Remarks: Rehung the LUIC sign near the former Glass Holes area which was found on the ground nearby.
Recommendations: Modify the LUIC Factsheet to state that the former Glass Holes area is currently being used for site composting operations. A fabric liner was installed on the existing grade to ensure there is no disruption/penetration into the soil.
Inspection attendees include R. Howe, J. Burke, W. Dorsch, R. Lee, E. Kramer, D. Hanley, T. Kneitel.

Location (AOC): Sewage Treatment Plant
Date of Inspection: 7/12/10_______________________________________
Name of Inspector(s): R. Howe, W. Dorsch, T. Green, D. Hanley
Purpose of Inspection: ☒ Routine (Scheduled Freq. of 2x/yr) ☐Heavy Rainfall ☐Reported Incident

A. Inspection Checklist

	Component	**Observed Condition**				**Further Action Req'd**	
		Excell.	**Fair**	**Poor**	**Not Applic.**	**Yes (describe)**	**No**
1.	**Landfill Cap/SoilCover:**						
	Vegetation (e.g. grass)	X					X
	Soil (Cap/Cover/Fill)	X					X
	Other: ________________________						
2.	**Drainage Structures:**						
	Standing Water				X		X
	Toe Drain				X		X
	Drainage Channels				X		X
	French Drains/Outfalls				X		X
	Subsurface Drainage	X					X
	Pipes/Outfalls				X		X
	Manholes				X		X
	Berms				X		X
	Roof Drains	X					X
	Recharge Areas						
	Other: _______________________						
3.	**Monitoring System:**						
	Soil Gas Wells				X		X
	Groundwater Wells	X					X
	Gas Vents				X		X
	Other: _____________________						
4.	**Site Access:**						
	Asphalt Access Road				X		X
	Crushed-concrete Access Road		X				X
	Fence	X					X
	Gates/locks	X					X
	Radiological Postings				X		X
	Other:						

5. Evidence of unauthorized work activities and/or unauthorized access has occurred? ☐ Yes ☒ No
If yes, describe evidence:

B. Description of Other Observations

Observed Conditions/Recommendations: No issues at STP. No unauthorized work visible at the abandoned sewer line area. No erosion of soil cover. Cover installed on sand trap located between the sand filters and the plant outfall. LUIC Fact Sheet Changes: Delete section of sewer pipe on figure that is south of East Fifth Ave. Under Remedial Action, add, Sludge was removed from manholes and a sewer line was capped and replaced with a new line. Under Admin. Controls, add control to prevent excavation or damage to the buried sewer line.

Location (AOC): Old Firehouse
Date of Inspection: 6/30/10____
Name of Inspector(s): R. Howe, W. Dorsch, D. Paquette, K. Conkling, D. Hanely
Purpose of Inspection: ☒ Routine (Scheduled Freq. of 1x/yr) ☐Heavy Rainfall ☐Reported Incident

A. Inspection Checklist

	Component	Observed Condition				Further Action Req'd	
		Excell.	Fair	Poor	Not Applic.	Yes (describe)	No
1.	**Landfill Cap/Soil Cover**						
	Vegetation (e.g. grass)	X					X
	Soil (Cap/Cover/Fill)				X		X
	Other: _________________________						
2.	**Drainage Structures:**						
	Standing Water				X		X
	Toe Drain				X		X
	Drainage Channels				X		X
	French Drains/Outfalls				X		X
	Subsurface Drainage				X		X
	Pipes/Outfalls				X		X
	Manholes				X		X
	Berms				X		X
	Roof Drains				X		X
	Recharge Areas				X		X
	Other: ________________						
3.	**Monitoring System:**						
	Soil Gas Wells				X		X
	Groundwater Wells	X					X
	Gas Vents				X		X
	Other: ___________				X		X
4.	**Site Access:**						
	Asphalt Access Road	X					X
	Crushed-concrete Access Road				X		X
	Fence				X		X
	Gates/locks				X		X
	Radiological Postings				X		X
	Other:_________________________						

5. Evidence of unauthorized work activities and/or unauthorized access has occurred? ☐ Yes ☒ No
If yes, describe evidence:

B. Description of Other Observations

Observed Conditions/Recommendations: The area currently consists grass and trees adjacent to the east side of the NSLS. LUIC Factsheet Changes, Replace existing factsheet photo.

Location (AOC): Old Incinerator Facility
Date of Inspection: 6/24/10____
Name of Inspector(s): R. Howe, W. Dorsch, K. Conkling, D. Hanley
Purpose of Inspection: ☒ Routine (Scheduled Freq. of 2x/yr) ☐Heavy Rainfall ☐Reported Incident

A. Inspection Checklist

Component	Observed Condition				Further Action Req'd	
	Excell.	Fair	Poor	Not Applic.	Yes (describe)	No
1. Landfill Cap/Soil Covers:						
Vegetation (e.g. grass)	X					X
Soil (Cap/Cover/Fill)	X					X
Other: _________________________						
2. Drainage Structures:						
Standing Water	X					X
Toe Drain				X		X
Drainage Channels				X		X
French Drains/Outfalls				X		X
Subsurface Drainage				X		X
Pipes/Outfalls				X		X
Manholes				X		X
Berms				X		X
Roof Drains				X		X
Recharge Areas						
Other: ________________________						
3. Monitoring System:						
Soil Gas Wells				X		X
Groundwater Wells	X					X
Gas Vents				X		X
Other: _________________________						
4. Site Access:						
Asphalt Access Road				X		X
Crushed-concrete Access Road				X		X
Fence				X		X
Gates/locks				X		X
Radiological Postings				X		X
Other:_________________________				X		X

5. Evidence of unauthorized work activities and/or unauthorized access has occurred? ☐ Yes ☒ No
If yes, describe evidence: ___________

B. Description of Other Observations

Observed Conditions/Recommendations: No soil erosional areas identified. Soil cover in good condition. LUIC Factsheet Changes: Add a Current Conditions Section that says the area consists of a grassy filed covered with at least 12” of topsoil. Delete reference and link to the OU I ROD and the Ash Pit Closeout Report. Change For Additional Information contact Bob Lee.

Location (AOC): Bubble Chamber
Date of Inspection: 6/30/10____
Name of Inspector(s): R. Howe, W. Dorsch, D. Paquette, K. Conkling, D. Hanley, M. VanEssendelft, Frank Craner
Purpose of Inspection: ☒ Routine (Scheduled Freq. of 1x/yr) ☐Heavy Rainfall ☐Reported Incident

A. Inspection Checklist

	Component	Observed Condition				Further Action Req'd	
		Excell.	Fair	Poor	Not Applic.	Yes (describe)	No
1.	**Landfill Cap/Soil Covers:**						
	Vegetation (e.g. grass)		X				X
	Soil (Cap/Cover/Fill)				X		X
	Other: ________________________						
2.	**Drainage Structures:**						
	Standing Water				X		X
	Toe Drain				X		X
	Drainage Channels				X		X
	French Drains/Outfalls				X		X
	Subsurface Drainage				X		X
	Pipes/Outfalls				X		X
	Manholes				X		X
	Berms				X		X
	Roof Drains				X		X
	Recharge Areas				X		X
	Other: _______________						
3.	**Monitoring System:**						
	Soil Gas Wells				X		X
	Groundwater Wells		X				X
	Gas Vents				X		X
	Other: __________				X		X
4.	**Site Access:**						
	Asphalt Access Road		X				X
	Crushed-concrete Access Road				X		X
	Fence	X					X
	Gates/locks	X					X
	Radiological Postings	X				For AGS Rad Storage	X
	Other: ________________________						

5. Evidence of unauthorized work activities and/or unauthorized access has occurred? ☐ Yes ☒ No

If yes, describe evidence: M. VanEssendelft from Collider Accelerator Dept (CA-D) and Frank Craner from ES attended the inspection and said there has been no unauthorized access to the posted/fenced rad storage area. In addition, any digging proposed for the area would be reviewed by the Groundwater Protection Group via the digging permit process.

B. Description of Other Observations

Observed Conditions/Recommendations: A portion of the area currently consists of a Collider Accelerator Dept. (CA-D) Bldg. 960 Waste Yard for outdoor storage of rad materials. It is fenced, locked, with rad postings, and paved. The remainder of the area to the north is open and consists of grass, pavement, and concrete slabs (no postings). LUIC Factsheet Changes: Add a Current Conditions Section that states the conditions described above.

Location (AOC): Low Mass Criticality Facility
Date of Inspection: 7/7/10_____________________________________
Name of Inspector(s): R. Howe, W. Dorsch, D. Paquette, K. Conkling, D. Hanley
Purpose of Inspection: ☒ Routine (Scheduled Freq. of 1x/yr) ☐Heavy Rainfall ☐Reported Incident

A. Inspection Checklist

Component	Observed Condition				Further Action Req'd	
	Excell.	Fair	Poor	Not Applic.	Yes (describe)	No
1. Landfill Cap/Soil Covers:						
Vegetation (e.g. grass)	X					X
Soil (Cap/Cover/Fill)				X		X
Other: ________________________						
2. Drainage Structures:						
Standing Water		X			Little water in basin	X
Toe Drain				X		X
Drainage Channels				X		X
French Drains/Outfalls				X		X
Subsurface Drainage	X					X
Pipes/Outfalls	X					X
Manholes				X		X
Berms	X					X
Roof Drains		X			Phragmites in basin	X
Recharge Areas				X		X
Other: _______________						
3. Monitoring System:						
Soil Gas Wells				X		X
Groundwater Wells	X					X
Gas Vents				X		X
Other: __________				X		X
4. Site Access:						
Asphalt Access Road				X		X
Crushed-concrete Access Road		X				X
Fence				X		X
Gates/locks				X		X
Radiological Postings				X		X
Other:________________________						

5. Evidence of unauthorized work activities and/or unauthorized access has occurred? ☐ Yes ☒ No
If yes, describe evidence:
____

____

B. Description of Other Observations

Observed Conditions/Recommendations: No IC issues. LUIC Factsheet: Add a Current Conditions section.

Location (AOC): AGS Storage Yards (1 and 2)
Date of Inspection: 6/30/10____
Name of Inspector(s): R. Howe, W. Dorsch, D. Paquette, K. Comkling, D. Hanley, M. VanEssendelft (CA-D), Frank Craner (ES)
Purpose of Inspection: ☒ Routine (Scheduled Freq. of 1x/yr) ☐Heavy Rainfall ☐Reported Incident

A. Inspection Checklist

	Component	**Observed Condition**				**Further Action Req'd**	
		Excell.	**Fair**	**Poor**	**Not Applic.**	**Yes (describe)**	**No**
1.	**Landfill Cap/Soil Covers:**						
	Vegetation (e.g. grass)				X		X
	Soil (Cap/Cover/Fill)				X		X
	Other: _________________________						
2.	**Drainage Structures:**						
	Standing Water				X		X
	Toe Drain				X		X
	Drainage Channels				X		X
	French Drains/Outfalls				X		X
	Subsurface Drainage				X		X
	Pipes/Outfalls				X		X
	Manholes				X		X
	Berms				X		X
	Roof Drains				X		X
	Recharge Areas				X		X
	Other: _______________						
3.	**Monitoring System:**						
	Soil Gas Wells				X		X
	Groundwater Wells	X					X
	Gas Vents				X		X
	Other: __________						
4.	**Site Access:**						
	Asphalt Access Road				X		X
	Crushed-concrete Access Road				X		X
	Fence				X		X
	Gates/locks	X					X
	Radiological Postings	X					X
	Other: _________________________						

5. Evidence of unauthorized work activities and/or unauthorized access has occurred? ☐ Yes ☒ No
If yes, describe evidence: M. VanEssendelft from Collider Accelerator Dept (CA-D) attended the inspection and said there has been no unauthorized access to the posted/fenced rad storage areas.

B. Description of Other Observations

Observed Conditions/Recommendations: The Bldg. 912 Steel Yard (Yard 1A) is a Radioactive Material Area (RMA). It is fenced, rad posted with a chain, and a contact sign. The Bldg. 912 Lead Yard (Yard 1B), is also identified as a RMA, and is rad posted, and secured with a fence and gate. LUIC Factsheet Changes: Storage Yard 1: Under Current Conditions, first sentence, change to, Yard 1A (Bldg. 912 Steel Yard) and Yard 1B (Bldg. 912 Lead Yard) are currently being used for storage by CA-D and are fenced and posted for radiological control purposes (i.e., Radioactive Material Area). Under Access and Engineered Controls, change to Radioactive Material Area. Highlight Yard 1B on the LUIC map. LUIC Factsheet Storage Yard 2 (AOC 18) Changes: Under Remedial Action, delete last sentence. Under LUIC Classification, first bullet, change to say, The site is currently used for industrial purposes.

Location (AOC): Bldg. 830 USTs and Pipe Leak
Date of Inspection: 6/30/10____
Name of Inspector(s): R. Howe, W. Dorsch, D. Paquette, K. Conkling, D. Hanley
Purpose of Inspection: ☒ Routine (Scheduled Freq. of 1x/yr) ☐Heavy Rainfall ☐Reported Incident

A. Inspection Checklist

Component	**Observed Condition**				**Further Action Req'd**	
	Excell.	**Fair**	**Poor**	**Not Applic.**	**Yes (describe)**	**No**
1. Landfill Cap/Soil Covers:						
Vegetation (e.g. grass)		X				X
Soil (Cap/Cover/Fill)				X		X
Other: _________________________						
2. Drainage Structures:						
Standing Water				X		X
Toe Drain				X		X
Drainage Channels				X		X
French Drains/Outfalls				X		X
Subsurface Drainage				X		X
Pipes/Outfalls				X		X
Manholes				X		X
Berms				X		X
Roof Drains				X		X
Recharge Areas				X		X
Other: _______________						
3. Monitoring System:						
Soil Gas Wells				X		X
Groundwater Wells		X				X
Gas Vents				X		X
Other: __________						
4. Site Access:						
Asphalt Access Road		X				X
Crushed-concrete Access Road				X		X
Fence		X				X
Gates/locks		X			Open, not locked	X
Radiological Postings	X				For Rad Storage Areas	X
Other: _________________________						

5. Evidence of unauthorized work activities and/or unauthorized access has occurred? ☐ Yes ☒ No
If yes, describe evidence: There doesn't appear to be, and any digging proposed for the area would be reviewed by the Groundwater Protection Group/LTRA via the digging permit process.

B. Description of Other Observations

Observed Conditions/Recommendations: The area currently consists of Bldg. 830 (occupied) by Energy, Environment and National Security Directorate (EENS) Environmental Sciences Dept., NSLS II Project Offices located in the mod trailer to the north , and outdoor connex storage, waste collection area, and rad waste storage areas. The yard is fenced but the gate is open/no lock. The remainder of the area is open and consists of grass and pavement/parking area.

Location (AOC): Building 208 Vapor Degreaser (AOC 26) and Warehouse Area
Date of Inspection: 11/19/09____________________________________
Name of Inspector(s): R. Howe, W. Dorsch, V. Racaniello
Purpose of Inspection: ☒ Routine (Scheduled Freq. of 1x/yr) ☐Heavy Rainfall ☐Reported Incident

A. Inspection Checklist

	Component	Observed Condition				Further Action Req'd	
		Excell.	Fair	Poor	Not Applic.	Yes (describe)	No
1.	**Landfill Cap/Soil Covers:**						
	Vegetation (e.g. grass)				X	NSLS II construction underway	X
	Soil (Cap/Cover/Fill)				X		X
	Other: _________________________						
2.	**Drainage Structures:**						
	Standing Water				X		X
	Toe Drain				X		X
	Drainage Channels				X		X
	French Drains/Outfalls				X		X
	Subsurface Drainage				X		X
	Pipes/Outfalls				X		X
	Manholes				X		X
	Berms				X		X
	Roof Drains				X		X
	Recharge Areas				X		X
	Other: ________________						
3.	**Monitoring System:**						
	Soil Gas Wells				X		X
	Groundwater Wells				X		X
	Gas Vents				X		X
	Other: ___________						
4.	**Site Access:**						
	Asphalt Access Road				X		X
	Crushed-concrete Access Road				X		X
	Fence				X		X
	Gates/locks	X				Constr. Zone Fenced	X
	Radiological Postings				X		X
	Other: ~~NSLS II Construction signs~~	X					X

5. Evidence of unauthorized work activities and/or unauthorized access has occurred? ☐ Yes ☒ No
If yes, describe evidence:
____

B. Description of Other Observations

Observed Conditions/Recommendations: The former Building 208, foundations, and the former warehouse area have been demolished and the construction of the NSLS II facility is in progress. Since this area will continue to be under the NSLS II building, there is no need to continue to perform annual LUIC inspections at this location. LUIC Factsheet Changes: Add a Current Conditions section referencing the NSLS II construction. Under Land Use Classification, first bullet, change to say that the area is used for industrial use. Update the third bullet to reference that the foundations were removed. Delete the engineered control for soil screening. Add link for the Closeout Report and reference the Factsheet for the Former Warehouse Area (Post NSLS II Construction). Also add this area to the OU I Soils and OU V Plan.

Location (AOC): Building 464 Mercury Contaminated Soils
Date of Inspection: 11/19/09______________________________________
Name of Inspector(s): R. Howe, W. Dorsch, V. Racaniello
Purpose of Inspection: ☒ Routine (Scheduled Freq. of 1x/yr) ☐Heavy Rainfall ☐Reported Incident

A. Inspection Checklist

Component	Observed Condition				Further Action Req'd	
	Excell.	**Fair**	**Poor**	**Not Applic.**	**Yes (describe)**	**No**
1. Landfill Cap/Soil Covers:						
Vegetation (e.g. grass)			X		ISB under construction	X
Soil (Cap/Cover/Fill)				X		X
Other: ________________________						
2. Drainage Structures:						
Standing Water				X		X
Toe Drain				X		X
Drainage Channels				X		X
French Drains/Outfalls				X		X
Subsurface Drainage				X		X
Pipes/Outfalls				X		X
Manholes				X		X
Berms				X		X
Roof Drains				X		X
Recharge Areas				X		X
3. Monitoring System:						
Soil Gas Wells				X		X
Groundwater Wells				X		X
Gas Vents				X		X
Other: __________						
4. Site Access:						
Asphalt Access Road				X		X
Crushed-concrete Access Road				X		X
Fence				X		X
Gates/locks				X		X
Radiological Postings				X		X
Other:________________________						

5. Evidence of unauthorized work activities and/or unauthorized access has occurred?☐ Yes ☒ No
If yes, describe evidence:

____

B. Description of Other Observations

Observed Conditions/Recommendations: Construction preparation work is underway on the Interdisciplinary Science Building (ISB) which will be located at the former mercury cleanup area. This area is immediately north of Bldg. 464. This work was coordinated via the digging permit process and there are no impacts on the institutional controls for this area. The area will continue to be used for industrial purposes. The OU III ROD does not specify institutional controls for this area. Since this area will be underneath the ISB, there is no need to continue performing annual LUIC inspections at this location. The remaining institutional controls will continue to apply. LUIC Factsheet: Add Current Conditions section, stating that the area is currently under construction for the ISB. An extension to the east portion of Bldg. 464 was completed in the fall of 2009. Under Land Use, add a bullet that says the area will continue as industrial use while the ISB is in use. Under Other, add that annual inspections of this area are no longer needed since it is located under the ISB. Also add Bldg. 464 area to the OU I and V Plan.

Location (AOC): Recharge Basins HS and HW (AOCs 24E, 24F)
Date of Inspection: 11/19/09
Name of Inspector(s): R. Howe, W. Dorsch, V. Racaniello
Purpose of Inspection: ☒ Routine (Scheduled Freq. of 2x/yr) ☐ Heavy Rainfall ☐ Reported Incident

A. Inspection Checklist

Component	**Observed Condition**				**Further Action Req'd**	
	Excell.	**Fair**	**Poor**	**Not Applic.**	**Yes (describe)**	**No**
1. Landfill Cap/Soil Covers:						
Vegetation (e.g. grass)				X		X
Soil (Cap/Cover/Fill)				X		X
Other: ____________						
2. Drainage Structures:						
Standing Water		X				X
Toe Drain				X		X
Drainage Channels				X		X
French Drains/Outfalls				X		X
Subsurface Drainage				X		X
Pipes/Outfalls				X		X
Manholes				X		X
Berms				X		X
Roof Drains	X					X
Recharge Areas				X		X
Other: ____________						
3. Monitoring System:						
Soil Gas Wells				X		X
Groundwater Wells				X		X
Gas Vents				X		X
Other: __________						
4. Site Access:						
Asphalt Access Road				X		X
Crushed-concrete Access Road				X		X
Fence				X		X
Gates/locks				x		X
Radiological Postings				X		X
Other:						

5. Evidence of unauthorized work activities and/or unauthorized access has occurred? ☐ Yes ☒ No
If yes, describe evidence:
____

B. Description of Other Observations

Observed Conditions/Recommendations: The basins continue to be use for recharge of stormwater. Since these basins are regulated under the New York State SPDES permits and any work in or near these basins are covered under the existing Work Planning and Control process, the digging permit process, and the BNL Natural Resource Management Plan, further LUIC inspections are not needed. LUIC Factsheet Changes: Add 24F to Factsheet title. For History, add bullet for Recharge Basin HW (AOC 24F) receives stormwater runoff from NSLS II area. For Admin Controls, last bullet, change details can be obtained from the SPDES permits and the NRMP. Under References, add link for the Natural Resource Management Plan. Revise The OU I Soils and OU V Plan to reflect no further need for LUIC inspections.

VIII. GROUNDWATER REMEDIES ☒ Applicable ☐ N/A 9/23/10

A. System OU III LIPA/Airport. Inspection attendees include V. Racaniello, E. Murphy, P. Pizzo, A. Steinhauff

1. **Construction Complete/System Operating** ☒ Yes ☐ No

Remarks: Construction is complete, system operating a new extraction well was added in 2007 to address contamination detected further to the west then originally anticipated.

B. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☒Good condition ☒ All required wells properly operating Needs Maintenance ☐ N/A
Remarks: All wells are operating however LIPA wells 1, 2 and 3 are in standby.

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance
Remarks____

3. **Spare Parts and Equipment**
☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☒ Carbon adsorbers
☐ Filters____
☐ Additive (*e.g.*, chelation agent, flocculent):
☐ Others____
☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☐ Quantity of groundwater treated annually________________
☐ Quantity of surface water treated annually________________
Remarks_ ____

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks:

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance
Remarks:

4. **Discharge Structure and Appurtenances**
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks: Injection and recirculation wells require routine maintenance to prevent clogging.

5. **Treatment Building(s)**
☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks: ______________________________

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks______________________________
____

D. Monitoring Data

1. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining
Remarks: VOC concentrations at Airport are low but stable in western extraction wells. Three of the four LIPA wells are currently in standby due to low VOC concentrations.

VIII. GROUNDWATER REMEDIES ☒ Applicable ☐ N/A 9/23/10

A. System OU III North Street/North Street East. Inspection attendees include V. Racaniello, E. Murphy, P. Pizzo, A. Steinhauff

1. **Construction Complete/System Operating** ☒ Yes ☐ No

Remarks: Construction is complete, systems both operating. Well NSE-2 is in standby and well NS-1 is pulse pumping

B. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**

☒ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A

Remarks: Well NS-1 and NSE-1 are pulse pumping. Well NSE-2 is in standby.

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**

☒ Good condition ☐ Needs Maintenance

Remarks____

3. **Spare Parts and Equipment**

☐ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)

☐ Metals removal ☐ Oil/water separation ☐ Bioremediation

☐ Air stripping ☒ Carbon adsorbers

☐ Filters____

☐ Additive (*e.g.*, chelation agent, flocculent):

☐ Others____

☒ Good condition ☐ Needs Maintenance

☒ Sampling ports properly marked and functional

☒ Sampling/maintenance log displayed and up to date

☒ Equipment properly identified

☐ Quantity of groundwater treated annually________________________

☐ Quantity of surface water treated annually________________________

Remarks____

2. **Electrical Enclosures and Panels** (properly rated and functional)

☐ N/A ☒ Good condition ☐ Needs Maintenance

Remarks:

3. **Tanks, Vaults, Storage Vessels**

☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance

Remarks____

4. **Discharge Structure and Appurtenances**

☐ N/A ☒ Good condition ☐ Needs Maintenance

Remarks: Injection wells need routine maintenance due to fouling (every 6 to 12 months).

5. **Treatment Building(s)**
☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks: ____
____

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks____
____

D. Monitoring Data

3. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

4. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

VIII. GROUNDWATER REMEDIES ☒ Applicable ☐ N/A 9/23/10

A. System OU VI AOC 28 EDB. Inspection attendees include V. Racaniello, E. Murphy, P. Pizzo, A. Steinhauff

1. **Construction Complete/System Operating** ☒ Yes ☐ No

B. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☒ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks:
____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance
Remarks____
____

3. **Spare Parts and Equipment**
☐ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks____
____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☒ Carbon adsorbers
☐ Filters____
☐ Additive (*e.g.*, chelation agent, flocculent):
☐ Others____
☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☐ Quantity of groundwater treated annually________________________
☐ Quantity of surface water treated annually________________________
Remarks____
____

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks:

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance
Remarks____
____

4. **Discharge Structure and Appurtenances**
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks: Injection wells require periodic maintenance

5. **Treatment Building(s)**
☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks: Soffit on east side of building needs repair.

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks____

D. Monitoring Data

5. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

6. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

VIII. GROUNDWATER REMEDIES ☒ Applicable ☐ N/A 9/23/10

A. System OU III Industrial Park East. Inspection attendees include V. Racaniello, E. Murphy, P. Pizzo, A. Steinhauff

1. **Construction Complete/System Operating** ☒ Yes ☐ No
Remarks: Construction is complete, system was approved for shutdown in 2010 and shutdown. System currently in standby.

B. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☒ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks: System is operational but in standby mode.

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance
Remarks____

3. **Spare Parts and Equipment**
☐ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☒ Carbon adsorbers
☐ Filters____
☐ Additive (*e.g.*, chelation agent, flocculent):
☐ Others____
☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☐ Quantity of groundwater treated annually________________________
☐ Quantity of surface water treated annually________________________
Remarks____

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks:

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance
Remarks____

4. **Discharge Structure and Appurtenances**
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks: When operating the injection wells require periodic maintenance

5.	**Treatment Building(s)** ☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair ☐ Chemicals and equipment properly stored Remarks:
6.	**Monitoring Wells** (pump and treatment remedy) ☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition ☒ All required wells located ☐ Needs Maintenance ☐ N/A Remarks: As per Petition for Shutdown installation of one additional Magothy monitoring well is planned to the south of the extraction wells near the LIPA Right Of Way.
D. Monitoring Data	
7.	Monitoring Data ☒ Is routinely submitted on time ☒ Is of acceptable quality
8.	Monitoring data suggests: ☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining Remarks: Cleanup goals have been met at this location for the Upper Glacial Aquifer.

VIII. GROUNDWATER REMEDIES ☒ Applicable ☐ N/A 9/23/10

A. System OU III Industrial Park. Inspection attendees include V. Racaniello, E. Murphy, P. Pizzo, A. Steinhauff

1. **Construction Complete/System Operating** ☒ Yes ☐ No
   Remarks: Wells 1,2 and 7 are in standby due to low VOC concentrations

B. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   ☒ Good condition ☒ All required wells properly operating ☒ Needs Maintenance ☐ N/A
   Remarks: Treatment wells UVB-1, UVB-2 and UVB-7 are shutdown due to low VOC concentrations in these wells.

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   ☒ Good condition ☐ Needs Maintenance
   Remarks____

3. **Spare Parts and Equipment**
   ☐ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
   Remarks____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
   ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
   ☒ Air stripping ☒ Carbon adsorbers (vapor phase)
   ☐ Filters____
   ☐ Additive (*e.g.*, chelation agent, flocculent):
   ☐ Others____
   ☒ Good condition ☐ Needs Maintenance
   ☒ Sampling ports properly marked and functional
   ☒ Sampling/maintenance log displayed and up to date
   ☒ Equipment properly identified
   ☐ Quantity of groundwater treated annually________________________
   ☐ Quantity of surface water treated annually________________________
   Remarks____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   ☐ N/A ☒ Good condition ☐ Needs Maintenance
   Remarks:

3. **Tanks, Vaults, Storage Vessels**
   ☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance
   Remarks____

4. **Discharge Structure and Appurtenances**
   ☐ N/A ☒ Good condition ☐ Needs Maintenance
   Remarks: These wells are recirculation wells with two screens and require frequent cleaning to keep them operational

5. **Treatment Building(s)**
☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks: ________________

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks____
____

D. Monitoring Data

9. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

10. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining
Remarks: System is approaching cleanup goals for system operation.

VIII. GROUNDWATER REMEDIES ☒ Applicable ☐ N/A 11/18/10

A. System OU III AOC 29 HFBR Tritium Pump and Recharge. Inspection attendees include V. Racaniello, E. Kramer, Adrian Steinhauff, John Burke, John Young, Bill Dorsch.

1. **Construction Complete/System Operating** ☒ Yes ☐ No

Remarks: An extraction well was added and the system began operating again in 2007 as a slug of higher concentrations was detected in this area.

B. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☒ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks: Well EW-16 and EW-11 are operating. Wells Ew-9 and EW-10 are in standby

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance
Remarks

3. **Spare Parts and Equipment**
☐ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☒ Carbon adsorbers
☐ Filters____
☐ Additive (*e.g.*, chelation agent, flocculent):
☐ Others____
☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☐ Quantity of groundwater treated annually________________
☐ Quantity of surface water treated annually________________
Remarks: Treatment is for VOCs

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks:

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance
Remarks____
____

4. **Discharge Structure and Appurtenances**
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks: Recharge basin is in excellent condition

5. **Treatment Building(s)**
☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks:

6.	**Monitoring Wells** (pump and treatment remedy) ☒ Properly secured/locked ☐ Functioning ☒ Routinely sampled ☒ Good condition ☒ All required wells located ☐ Needs Maintenance ☐ N/A Remarks
D. Monitoring Data	
11.	Monitoring Data ☒ Is routinely submitted on time ☒ Is of acceptable quality
12.	Monitoring data suggests: ☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

VIII. GROUNDWATER REMEDIES ☒ Applicable ☐ N/A 11/18/10

A. System OU I South Boundary (Bldg. 598) Inspection attendees include V. Racaniello, , E. Kramer, Bill Dorsch, Adrian Steinhauff, John Young

1. **Construction Complete/System Operating** ☒ Yes ☐ No
Remarks: System approaching Remedial Action Objectives.

B. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☐ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks:

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance
Remarks

3. **Spare Parts and Equipment**
☐ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☒ Air stripping ☐ Carbon adsorbers
☐ Filters____
☐ Additive (*e.g.*, chelation agent, flocculent)_sodium polyphosphate is not used________
☐ Others____
☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☐ Quantity of groundwater treated annually________________________
☐ Quantity of surface water treated annually________________________
Remarks____

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks____

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance

4. **Discharge Structure and Appurtenances**
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks: Recharge Basin is in excellent condition

5. **Treatment Building(s)**
☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks:

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☐ Functioning ☒ Routinely sampled ☐ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks

D. Monitoring Data

13. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

14. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining
Remarks: Treatment system has met cleanup goals except for one small “Hot Spot” upgradient of the extraction wells.

VIII. GROUNDWATER REMEDIES ☒ Applicable ☐ N/A 10/27/10

A. System OU III South Boundary (Bldg.517 and Bldg 518) Inspection attendees include V. Racaniello,, E. Kramer, Bill Dorsch, Adrian Steinhauff, John Young

1. **Construction Complete/System Operating** ☒ Yes ☐ No
   Remarks: Wells EW-6,7,8 and 12 are in standby due to low VOC concentrations.

B. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   ☒ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A
   Remarks:

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   ☒ Good condition ☐ Needs Maintenance
   Remarks

3. **Spare Parts and Equipment**
   ☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
   Remarks____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
   ☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
   ☒ Air stripping ☐ Carbon adsorbers
   ☐ Filters____
   ☐ Additive (*e.g.*, chelation agent, flocculent)_sodium polyphosphate is not used________
   ☐ Others____
   ☒ Good condition ☐ Needs Maintenance
   ☒ Sampling ports properly marked and functional
   ☒ Sampling/maintenance log displayed and up to date
   ☒ Equipment properly identified
   ☐ Quantity of groundwater treated annually________________________
   ☐ Quantity of surface water treated annually________________________
   Remarks____
   ____

2. **Electrical Enclosures and Panels** (properly rated and functional)
   ☐ N/A ☒ Good condition ☐ Needs Maintenance
   Remarks____
   ____

3. **Tanks, Vaults, Storage Vessels**
   ☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance

4. **Discharge Structure and Appurtenances**
   ☐ N/A ☒ Good condition ☐ Needs Maintenance
   Remarks: Recharge Basins are in excellent condition but require occasional maintenance

5. **Treatment Building(s)**
   ☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
   ☐ Chemicals and equipment properly stored
   Remarks:

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☐ Functioning ☒ Routinely sampled ☐ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks

D. Monitoring Data

15. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

16. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

Remarks: Three of seven extraction wells are currently operating. The four eastern wells have met the cleanup goals.

VIII. GROUNDWATER REMEDIES ☒ Applicable ☐ N/A 11/18/10

A. System OU III Middle Road (Bldg.516 and 519) Inspection attendees include V. Racaniello, , E. Kramer, Bill Dorsch, Adrian Steinhauff, John Young

1. **Construction Complete/System Operating** ☒ Yes ☐ No

Remarks: The three eastern extraction wells RW-4, RW-5 and RW-6 are in standby and have met the Remedial Action Objectives for this project.

B. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☐ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks:

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance
Remarks

3. **Spare Parts and Equipment**
☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☒ Air stripping ☐ Carbon adsorbers
☐ Filters____
☐ Additive (*e.g.*, chelation agent, flocculent)_sodium polyphosphate is not used________
☐ Others____
☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☐ Quantity of groundwater treated annually________________________
☐ Quantity of surface water treated annually________________________
Remarks____

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks____

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance

4. **Discharge Structure and Appurtenances**
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks: Recharge Basins are is in excellent condition but require occasional maintance

5. **Treatment Building(s)**
☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks:

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☐ Functioning ☒ Routinely sampled ☐ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks

D. Monitoring Data

17. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

18. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

Remarks: The three eastern extraction wells have met cleanup goals and are in standby. There is currently an investigation on the eastern edge of the plume concerning VOCs that may be deeper or further to the east of the three eastern extraction wells. The results may require followup actions from additional monitoring wells up to an additional extraction well on the eastern edge of the plume.

VIII. GROUNDWATER REMEDIES ☒ Applicable ☐ N/A 10/27/10

A. System OU III Western South Boundary (Bldg. 539) Inspection attendees include V. Racaniello, E. Kramer, Bill Dorsch, Adrian Steinhauff, John Young

1. **Construction Complete/System Operating** ☒ Yes ☐ No
Remarks: Well WSB-2 is being pulse pumped

B. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☐ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks:

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance
Remarks

3. **Spare Parts and Equipment**
☐ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☒ Air stripping ☐ Carbon adsorbers
☐ Filters____
☐ Additive (*e.g.*, chelation agent, flocculent)_sodium polyphosphate is not used________
☐ Others____
☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☐ Quantity of groundwater treated annually________________________
☐ Quantity of surface water treated annually________________________
Remarks____

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks____

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance

4. **Discharge Structure and Appurtenances**
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks: Recharge Basin is in good condition

5. **Treatment Building(s)**
☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks: Need insulation on tower influent piping.

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☐ Functioning ☒ Routinely sampled ☐ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks

D. Monitoring Data

19. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

20. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining
Remarks: A groundwater investigation in 2008/2009 showed higher then expected upgradient concentrations of TCA and Freon this has extended the expected duration of this systems operation. Further upgradient investigation of the Freon is ongoing.

VIII. GROUNDWATER REMEDIES ☒ Applicable ☐ N/A 10/27/10

A. System OU III Building 96 (Bldg. TR-854, TR-866, TR-867, TR_868) Inspection attendees include V. Racaniello, , E. Kramer, Bill Dorsch, Adrian Steinhauff, John Young

1. **Construction Complete/System Operating** ☒ Yes ☐ No
Remarks:

B. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☐ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks:

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance
Remarks

3. **Spare Parts and Equipment**
☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☒ Air stripping ☐ Carbon adsorbers
☐ Filters____
☐ Additive (*e.g.*, chelation agent, flocculent)_sodium polyphosphate is not used________
☐ Others____
☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☐ Quantity of groundwater treated annually________________________
☐ Quantity of surface water treated annually________________________
Remarks: Well RTW-1 was changed from a recirculation well to a pumping well in 2007 and a Hexavalent chromium treatment system installed in the RTW-1 treatment building. The Hexavalent Chromium treatment is no longer required as concentrations have dropped to below required concentrations.

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks____
____

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☐ Proper secondary containment ☐ Needs Maintenance

4. **Discharge Structure and Appurtenances**
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks: Recharge Basin is in excellent condition

5. **Treatment Building(s)**
☐ N/A ☒ Good condition (esp. roof and doorways) ☒ Needs repair
☐ Chemicals and equipment properly stored
Remarks: Building 868 has a minor roof leak that needs repair.

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☐ Functioning ☒ Routinely sampled ☐ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks

D. Monitoring Data

21. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

22. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

Remarks: A hot spot of soil contamination was identified in 2008 that was acting as a continuing source for groundwater contamination. From August to October 2010 approximately 370 yards of contaminated soil was excavated and disposed of. It is expected that the treatment system will need to operate for three to six additional years to reach the cleanup goals (2013 – 2016).

VIII. GROUNDWATER REMEDIES ☒ Applicable ☐ N/A 10/27/10

A. System OU III Sr-90 Chemical Holes (Bldg. 670) Inspection attendees include V. Racaniello, E. Kramer, C. Shuster, A. Steinhauff, Bill Dorsch

1. **Construction Complete/System Operating** ☒ Yes ☒ No

Remarks: System was modified in 2007 and two additional extraction wells were added.

B. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☒ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks: Extraction well 1 is being pulse pumped.

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance
Remarks____

3. **Spare Parts and Equipment**
☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☐ Carbon adsorbers
☒ Filters: ion exchange________________________
☐ Additive (*e.g.*, chelation agent, flocculent)________________________
☐ Others________________________
☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☐ Quantity of groundwater treated annually________________
☐ Quantity of surface water treated annually________________
Remarks: Resin ;has been successful at removing the SR90 from the groundwater and has performed better then expected.

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks____

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☒ Proper secondary containment ☐ Needs Maintenance
Remarks: ________________________

4. **Discharge Structure and Appurtenances**
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks: Drywells have never required maintenance.

5. **Treatment Building(s)**
☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks:

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☐ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks____

D. Monitoring Data

23. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

24. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

Remarks: Concentrations in the two downgradient extraction wells have declined. Well 1 has had stable concentrations for several years now.

VIII. GROUNDWATER REMEDIES ☒ Applicable ☐ N/A 11/18/10

A. System OU III Sr-90 BGRR/WCF (Bldg. 855) Inspection attendees include V. Racaniello, E. Kramer, A. Steinhauff, Bill Dorsch, John Young

1. **Construction Complete/System Operating** ☒ Yes ☐ No
Remarks: Currently adding four new extraction wells to the system.

B. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
☒ Good condition ☐ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☒ Good condition ☐ Needs Maintenance
Remarks: ________________

3. **Spare Parts and Equipment**
☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☒ Carbon adsorbers
☒ Filters: ion exchange ___
☐ Additive (*e.g.*, chelation agent, flocculent)________________________________
☐ Others____
☒ Good condition ☐ Needs Maintenance
☒ Sampling ports properly marked and functional
☒ Sampling/maintenance log displayed and up to date
☒ Equipment properly identified
☐ Quantity of groundwater treated annually________________________
☐ Quantity of surface water treated annually________________________
Remarks: Resin has performed better then expecting in removing Sr-90 from groundwater.

2. **Electrical Enclosures and Panels** (properly rated and functional)
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks____

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☒ Proper secondary containment ☐ Needs Maintenance
Remarks____

4. **Discharge Structure and Appurtenances**
☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks: Drywells have never required maintenance

5. **Treatment Building(s)**
☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks____

6. **Monitoring Wells** (pump and treatment remedy)
☒ Properly secured/locked ☐ Functioning ☒ Routinely sampled ☒ Good condition
☐ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks____

D. Monitoring Data

25. Monitoring Data
☒ Is routinely submitted on time ☒ Is of acceptable quality

26. Monitoring data suggests:
☒ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

Remarks: Plume is contained upgradient of the existing five wells. Four new wells are being added to address downgradient portions of these plumes. The monitoring data indicates that there may be a continuing source of Sr-90 upgradient of extraction well 3, which is located immediately downgradient of the BGRR.

E. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☒Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒All required wells located ☐ Needs Maintenance ☐ N/A
Remarks: A portion of each groundwater remedy relies on some natural attenuation.________________

IX. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

X. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

With the exception of remaining soil excavation at OU I and the BGRR pile and bioshield removal, all soil, sediment, and groundwater remedies for the seven RODs at the site have been implemented and are functioned as designed. This includes the excavation and off-site disposal of contaminated soils, sediments, tanks, as well as the installation and operations initiated for all groundwater treatment systems. All of the remedies are being implemented in accordance with the RODs and the ESD. The remedies are expected to be protective upon attainment of soil cleanup goals once excavation is complete, and groundwater cleanup goals.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The VOC treatment systems operated without any significant down time or issues over the last eight years and have consistently met the state equivalency discharge requirements (although there have been a few pH excursions due to the natural groundwater conditions). The systems have been physically inspected typically on a daily basis. However, the frequency of physical inspections will generally be reduced starting in 2005 due to the significant operating history, the increase in the number of systems off of BNL property, and the availability of wireless system monitoring/alarms.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

- See above. See Five Year Review Section 7.0.

D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. Opportunities are routinely identified. See Five Year Review Section 7.0______________ ____

Attachment 4

Interview Records

INTERVIEW RECORD

Site Name: Brookhaven National Laboratory	**EPA ID No.:**
Subject: 2011 Five-Year Review	**Time:** 2:00 **Date:** 7/27/10
Type: X Telephone ☐ Visit ☐ Other **Location of Visit:**	☐ Incoming ☐ Outgoing

Contact Made By:

Name: S. Johnson	**Title:**	**Organization:** CEGPA

Individual Contacted:

Name: Doug Pocze	**Title:** Remedial Project Manager	**Organization:** EPA II

Telephone No.: 212-637-4432 **Fax No.:** **E-Mail Address:** pocze.doug@epa.gov	**Street Address:** 290 Broadway **City, State, Zip:** NY, NY 10007-1866

Summary of Conversation

Mr. Pocze said that he was very pleased with BNL and DOE especially considering the number of sites included in the cleanup. He said that the annual groundwater summary was helpful and served as "one-stop shopping" for information on the groundwater treatment systems. The IAG calls have been a big help and make it easy to keep track of the projects. The working relationship is non-adversarial.

He said it was hard to say if there are any specific aspects of the cleanup that should be focused on. He thought there was a good split among the projects. The big ticket projects are the ARRA-funded projects and groundwater, and the Peconic River to a lesser extent.

Mr. Pocze said he felt well informed about the cleanup projects. He said EPA is very interested in green initiatives and mentioned that DOE had been very helpful in getting him information on the recycling of materials such as concrete from the Fan House removal.

He feels that the public is sufficiently informed through the Community Advisory Council, the Roundtable, and public notices. He noted that the Lab also holds ceremonies and invites the community in to participate.

He said that he believes the remedies are functioning as expected. Some do need tweaking such as the Peconic River. He feels comfortable with them.

The particular component of the cleanup that concerns him is the long-term cleanups that go out for 50 years. There is concern about the achieving the cleanup goals if the property is transferred or sold at some point in the future. He said there are problems with this at other federal sites.

INTERVIEW RECORD

Site Name: Brookhaven National Laboratory		**EPA ID No.:**
Subject: 2011 Five-Year Review		**Time:** 2:00 **Date:** 7/27/10
Type: X Telephone ☐ Visit ☐ Other **Location of Visit:**		☐ Incoming ☐ Outgoing
Contact Made By:		
Name: S. Johnson	**Title:**	**Organization:** CEGPA
Individual Contacted:		
Name: Doug Pocze	**Title:** Remedial Project Manager	**Organization:** EPA II
Telephone No.: 212-637-4432 **Fax No.:** **E-Mail Address:** pocze.doug@epa.gov	**Street Address:** 290 Broadway **City, State, Zip:** NY, NY 10007-1866	

Summary of Conversation

Mr. Pocze noted that vapor intrusion seems to be an issue in some areas. He said it doesn't seem to be a problem at BNL because the contamination is deeper in the aquifer. It could become a problem if things change; it's a big issue for the Department of Health.

Mr. Pocze said that DOE does a good job and are usually ahead of EPA. He mentioned that use of rail versus shipping by truck was one way that is cost saving and more efficient. He mentioned that EPA is working with the USGS on a Long Island groundwater study and said that sharing well data could be an opportunity to optimize operations.

He felt that BNL and DOE are maintaining institutional controls but that will be harder if there is a transfer of property; it will be more difficult in the long-term. He mentioned the Land Use plan as a good document to have. He said that deed restrictions get lost over time, that people have a tendency to forget, and that institutional knowledge is lost. He said there is soil at RHIC that will need to be addressed (removed) in the future and he is concerned the information will be lost. He said that the HFBR will be a good example to follow as the years go by. Mr. Pocze commented that he is pleased that the Laboratory has a regulatory affairs person that he can contact first with any questions regarding the cleanup. This saves him time as he can then be directed to the correct person to answer his questions. This is especially helpful during staff transition; he still has one person to go to.

INTERVIEW RECORD

Site Name: Brookhaven National Laboratory
EPA ID No.:
Subject: 2011 Five-Year Review
Time: 4:00 **Date:** 7/27/10
Type: X Telephone ☐ Visit ☐ Other
☐ Incoming ☐ Outgoing
Location of Visit:

Contact Made By:

Name: S. Johnson
Title:
Organization: CEGPA

Individual Contacted:

Name: Chek Beng Ng, P.E.
Title: Remedial Project Manager
Organization: NYSDEC
Telephone No.: 518-402-9620
Fax No.:
E-Mail Address: cbng@gw.dec.state.ny.us
Street Address: 625 Broadway, 11th Floor
City, State, Zip: Albany, NY 12233-7015

Summary of Conversation

Mr. Ng stated that his overall impression of the cleanup at BNL is pretty good. BNL is trying to do what it can to clean up the OUs as quickly as possible. He mentioned the removal of the HFBR control rod blades as an example. He said that the cleanup in general is progressing well and thought there maybe some RAD contamination that could be paid more attention, particularly the FHWMF perimeter soils. He said that shouldn't be forgotten.

He said there is nothing to indicate that the remedies are not functioning as expected. Mr. Ng thinks that the future decommissioning and dismantlement of the HFBR vessel and the confinement building may pose a higher degree of difficulty.

Mr. Ng thinks that the biggest risk in achieving the soil and groundwater cleanup objectives would be to completely miss something. So far, DOE and the Lab have done a good job installing temporary wells where needed and the groundwater status report every year is good, but that has to continue or there is a risk of missing a groundwater plume that could migrate off-site.

Mr. Ng believes that BNL and DOE are actively managing the long-term cleanup and properly maintaining the institutional controls. He mentioned the Land Use and Institutional Controls Mapping website which he has used and noted that the institutional controls have been agreed on by the IAG. He feels the spirit of the RODs is being followed.

He believes that management of the cleanup has gone smoothly; his management is happy with the progress and said they are impressed with the early HFBR control rod blade removal and with the removal of the BGRR graphite pile. He hopes the momentum will continue.

INTERVIEW RECORD

Site Name: Brookhaven National Laboratory	**EPA ID No.:**
Subject: 2011 Five-Year Review	**Time:** 10:20 **Date:** 7/27/10
Type: X Telephone ☐ Visit ☐ Other **Location of Visit:**	☐ Incoming ☐ Outgoing

Contact Made By:

Name: S. Johnson	**Title:**	**Organization:** CEGPA

Individual Contacted:

Name: David O'Hehir	**Title:** Environmental Radiation Specialist	**Organization:** NYSDEC

Telephone No.: 518-402-8579 **Fax No.:** **E-Mail Address:** djohehir@gw.dec.state.ny.us	**Street Address:** 625 Broadway, 9th Floor **City, State, Zip:** Albany, NY 12233-7255

Summary of Conversation

Mr. O'Hehir stated that he had been with the project for just about a year. He thinks it is going well. DOE has been very responsive to the IAG, meeting their concerns. He noted several times that the American Reinvestment and Recovery Act (ARRA) funding has stepped up the cleanup.

There were no particular areas that he felt should be focused on, but did mention the Peconic River since hot spots are continuously being found during sampling.

He has gone back to examine the RODs when reviewing Work Plans for the various projects. He has asked for the rationale behind some of the decisions and thinks some things could have been done differently, but thinks that overall they are functioning as written.

One particular difficulty may be achieving the cleanup goals in the Peconic River as the water levels change. There are higher water levels in the river during the summer when previously the river was dry during the same period.

Overall, Mr. O'Hehir thinks that DOE has done a good job with the groundwater project. Additional wells have been added when needed, there's been great progress. He expressed some concern that the resources continue to be available to stay on top of the project.

He feels that BNL and DOE are actively managing the long-term cleanup operations and properly maintaining appropriate institutional controls. The ARRA funding helped to move the cleanup forward so that it will be done by 2011 instead of 2020. The goal for the BGRR and HFBR projects will be met a head of time. DOE has to keep on top of the groundwater projects. He did not have any suggestions or recommendations regarding management of the cleanup.

INTERVIEW RECORD

Site Name: Brookhaven National Laboratory | **EPA ID No.:**

Subject: 2011 Five-Year Review | **Time:** 10:13 **Date:** 7/28/10

Type: X Telephone ☐ Visit ☐ Other | ☐ Incoming ☐ Outgoing

Location of Visit:

Contact Made By:

Name: S. Johnson	**Title:**	**Organization:** CEGPA

Individual Contacted:

Name: Martin Trent	**Title:** Chief, Office of Ecology	**Organization:** SCDHS

Telephone No.: 631-852-5750
Fax No.:
E-Mail Address:
martin.trent@suffolkcountyny.gov

Street Address: 360 Yaphank Ave., Ste. 3B
City, State, Zip: Yaphank, NY 11980

Summary of Conversation

Mr. Trent's overall impression of the cleanup is that the Lab is earnestly trying to do a good job. He thinks that the ARRA funding has been very helpful. He said that his focus has been on groundwater and the Peconic River. The Lab has made them priorities and should continue to make them the priority. He feels well informed and said that he gets plenty of material on the cleanup.

He believes that the remedies are functioning as expected and said that he was involved with the selection of many of them. He thinks that DOE and the Lab are doing a good job and that the Lab has adjusted the remedies and been flexible when they needed to be.

Mr. Trent said that he really isn't involved in the operational or maintenance aspects of the cleanup so he did not know of opportunities for cost saving or efficiency. He did think that one of the risks to the cleanup was the long-term remedies and the required long-term follow-up. He thought the economy could have some impact there and hoped that the DOE and Lab would continue to demonstrate their current level of commitment in the future.

He believes that the long-term cleanup operations and institutional controls are being actively managed. He said he has been working with the Lab since 1979. Since the early years, the level of openness and willingness to work with the County has changed markedly. He urges the Lab and DOE to investigate potential problems. He feels that a good job is being done with the legacy issues but there may be things that aren't known yet. He urges the Lab and DOE to remain vigilant.

INTERVIEW RECORD

Site Name: Brookhaven National Laboratory	**EPA ID No.:**
Subject: 2011 Five-Year Review	**Time:** 12:00 **Date:** 8/2/10
Type: X Telephone ☐ Visit ☐ Other **Location of Visit:**	☐ Incoming ☐ Outgoing

Contact Made By:

Name: S. Johnson	**Title:**	**Organization:** CEGPA

Individual Contacted:

Name: Bill Faulk	**Title:** Aide to SC Leg. Ed Romaine and BER Chair	**Organization:** BER

Telephone No.: 631-852-3200 **Fax No.:** **E-Mail Address:** bill.faulk@suffolkcountyny.gov	**Street Address:** 423 Griffing Avenue **City, State, Zip:** Riverhead, NY 11901

Summary of Conversation

Mr. Faulk stated that he had a positive impression of the cleanup at BNL. He said that he feels well informed about the clean-up, however, while the Community Advisory Council (CAC) and the Brookhaven Executive Roundtable (BER) are well informed, he does not think the general public is as well informed as they could be. He wasn't sure what the solution would be as he realizes that the local media doesn't always respond to press releases.

Mr. Faulk feels that to the best of his knowledge the remedies are functioning as expected. He thought that existing regulations had an impact on the soil and groundwater cleanup objectives and feels that BNL and DOE are actively managing the long-term cleanup operations. He had no comments or suggestions regarding the cleanup.

INTERVIEW RECORD

Site Name: Brookhaven National Laboratory
EPA ID No.:
Subject: 2011 Five-Year Review
Time: 10:00 **Date:** 8/2/10
Type: ☐ Telephone X Visit ☐ Other
☐ Incoming ☐ Outgoing
Location of Visit: DOE Site Office, Bldg. 464

Contact Made By:

Name: S. Johnson
Title:
Organization: CEGPA

Individual Contacted:

Names: Steven Feinberg and Terri Kneitel
Titles: Federal Project Director and Project Engineer
Organization: DOE
Telephone No.: 631-344-2112
Fax No.:
E-Mail Addresses: sfeinberg@bnl.gov and tkneitel@bnl.gov
Street Address: Bell Avenue
City, State, Zip: Upton, NY 11973

Summary of Conversation

Joint interview with Steven Feinberg, DOE Federal Project Director and Terri Kneitel, DOE Project Engineer. DOE Headquarters Career Development Program Intern Lisa Phillips was also present.

Mr. Feinberg and Ms. Kneitel both feel the cleanup is going well. When asked about specific aspects of the cleanup to focus on during the review Mr. Feinberg mentioned the expansiveness of the cleanup and Ms. Kneitel noted that additional source contamination has been found in some areas, such as Building 96, after the initial cleanup. She expressed concern about meeting the ROD goals if additional sources are found and feels this could also be a risk to achieving cleanup objectives.

Both Mr. Feinberg and Ms. Kneitel believe that the remedies are functioning as expected. Ms. Kneitel feels that a good job is being done in identifying and implementing cost savings by the Groundwater Protection Group. She noted that performance of wells is looked at annually. Mr. Feinberg mentioned the savings on the filter material for the SR-90 treatment system.

Ms. Kneitel was not aware of any upcoming changes to federal laws, however, the transition within DOE for long term surveillance and monitoring, from the Office of Environmental Management (EM) to the Office of Science (SC) in the next fiscal year (at the end of FY11) was mentioned. Ms. Kneitel noted that it will take vigilance to ensure the cleanup goals are obtained in the long-term.

On management of the cleanup, Mr. Feinberg commented that getting information and updates to interested parties continues to be important.

INTERVIEW RECORD

Site Name: Brookhaven National Laboratory	**EPA ID No.:**
Subject: 2011 Five-Year Review	**Time:** 10:05 **Date:** 8/3/10
Type: ☐ Telephone X Visit ☐ Other **Location of Visit:** BNL RSB, Comm. Relations Offices	☐ Incoming ☐ Outgoing

Contact Made By:

Name: S. Johnson	**Title:**	**Organization:** CEGPA

Individual Contacted:

Name: Gerald Granzen	**Title:** Sr. Environmental Engineer	**Organization:** DOE

Telephone No.: 631-344-4089 **Fax No.:** **E-Mail Address:** ggranzen@bnl.gov	**Street Address:** Bell Avenue **City, State, Zip:** Upton, NY 11973

Summary of Conversation

Mr. Granzen stated that his impression of the BNL cleanup is generally positive, that it's very extensive, and very expensive. The specific aspects of the cleanup that he feels should be of particular focus are the soil and groundwater cleanups and any "loose ends."

Mr. Granzen said that he feels well informed about the cleanup and that the Lab does a good job informing the public. He believes that with some adjustments, as necessary (and the Groundwater Protection Group is good about making them), the RODs are functioning as expected. He feels that the SR-90 plume is difficult to deal with and also mentioned the residual contaminated soils along Brookhaven Avenue. He feels that increased communications between the BNL Environmental Protection Group and Regulators who oversee the Interagency Agreement (IAG) is needed. Mr. Granzen was not aware of any recent or upcoming changes to any laws or regulations.

When asked about opportunities to optimize operations and cost savings, Mr. Granzen noted that as the cleanups are winding down, oversight and management seem to be a bit top heavy. He thought the need might be less for the monitoring phase of the cleanup. He feels the biggest risks to achieving the soil and groundwater cleanup objectives are uncharacterized soil and the shifting or mixing of groundwater plumes.

Mr. Granzen feels that BNL (and DOE) are actively managing the cleanup. He had no comments or suggestions other than to say that the DOE shift from EM to Office of Science (SC) should be done with care and there needs to be adequate funding to ensure the long-term cleanup objectives are completed.

INTERVIEW RECORD

Site Name: Brookhaven National Laboratory		**EPA ID No.:**
Subject: 2011 Five-Year Review		**Time:** 10:04 **Date:** 8/4/10
Type: X Telephone ☐ Visit ☐ Other **Location of Visit:**		☐ Incoming ☐ Outgoing

Contact Made By:

Name: S. Johnson	**Title:**	**Organization:** CEGPA

Individual Contacted:

Name: Steve Karpinski	**Title:** Public Health Specialist, Bureau of Environmental Exposure Investigations	**Organization:** NYSDOH

Telephone No.: 518-402-7880 **Fax No.:** **E-Mail Address:** sxk23@health.state.ny.us	**Street Address:** 547 River Street **City, State, Zip:** Troy, NY 12180-2216

Summary of Conversation

Mr. Karpinski stated that he has only been with the project for approximately two years, but his overall impression of the cleanup is good. He is impressed with the level of detail and quality and comprehensiveness of the information that is given to him. He did not have any specific aspects of the cleanup that he felt should be focused on during the review and he feels well informed about cleanup activities and progress.

Mr. Karpinski hasn't had too much of an opportunity to go back to review the Records of Decision (RODs), but based on his interactions with the other regulators, he feels that the remedies are functioning as expected. He feels that the biggest risk to achieving the cleanup objectives is ensuring that cleanup activities continue to function as intended. He noted that nothing will be accomplished in the short-term, but maintaining the momentum of the remedial activities is important so that the objectives are obtained in as short a time as possible.

Mr. Karpinski does feel that BNL and DOE are actively managing the long-term cleanup operations. He has been impressed with the level of detail and flow of information; he did not have any additional recommendations or comments about the management of the cleanup.

INTERVIEW RECORD

Site Name: Brookhaven National Laboratory	**EPA ID No.:**
Subject: 2011 Five-Year Review	**Time:** 1:54 **Date:** 8/6/10
Type: X Telephone ☐ Visit ☐ Other **Location of Visit:**	☐ Incoming ☐ Outgoing

Contact Made By:

Name: S. Johnson	**Title:**	**Organization:** CEGPA

Individual Contacted:

Name: Ernie Lewis	**Title:** Experimental Scientific Associate, BNL	**Organization:** Member, BNL Envoy Program

Telephone No.: 631-344-7406 **Fax No.:** **E-Mail Address:** elewis@bnl.gov	**Street Address:** **City, State, Zip:** Upton, NY 11973

Summary of Conversation

Mr. Lewis said it is his impression that quite a lot of cleanup has been done at BNL. He said he does not consider himself to be well informed about the cleanup (by his own choice) but information has been available. It is his impression that the cleanup is being actively managed; he had no suggestions or comments to add.

INTERVIEW RECORD

Site Name: Brookhaven National Laboratory	**EPA ID No.:**
Subject: 2011 Five-Year Review	**Time:** **Date:** 8/11/10
Type: ☐ Telephone ☒ Visit Other **Location of Visit:** SCDHS in Yaphank	☐ Incoming ☐ Outgoing

Contact Made By:

Name: Robert Howe	**Title:**	**Organization:** GPG

Individual Contacted:

Name: Andrew Rapiejko	**Title:**	**Organization:** SCDHS

Telephone No.: 631-852-5810 **Fax No.:** **E-Mail Address:** andrew.rapiejko@suffolkcountyny.gov	**Street Address:** 360 Yaphank Ave., Ste. 3B **City, State, Zip:** Yaphank, NY 11980

Summary of Conversation

Mr. Rapiejko commented during the Annual Groundwater Status Report briefing that he would like to see clarified when (what years) the 50 years of Institutional Controls for the different soil and reactor radionuclide cleanup projects starts and ends. Without the actual years it is very confusing.

Attachment 5

Operable Unit Cleanup Levels Matrix

Attachment 5
Operable Unit Cleanup Levels Matrix

Operable Unit	Contaminants of Concern	Cleanup Levels			Note any Changes to Cleanup Levels	Remedial Action Objectives
		Soil		Groundwater		
		Residential	Industrial			
I	Cesium-137	23 pCi/g	67 pCi/g			Prevent or minimize: 1. Leaching of contaminants from soil into groundwater, 2. Human exposure from surface and subsurface soil, 3. Uptake to ecological receptors. Rad soil cleanup levels are based on 15 mRem/year above background. ALARA goal is 10 mRem/year above background.
	Strontium-90	15 pCi/g	15 pCi/g	8 pCi/L		
	Radium-226	5 pCi/g	5 pCi/g			
	Lead	400 mg/kg				
	Mercury	1.84 mg/kg				
	1,2-Dichloroethane			5 µg/L		
	Chloroethane			5 µg/L		
II	Cesium-137	23 pCi/g	67 pCi/g			Documented in the OU I and III RODs.
	Tritium			20,000 pCi/L		
	Sodium-22			400 pCi/L		
III	1,1,1-Trichloroethane			5 µg/L		1. Meet MCLs for VOCs and tritium in Upper Glacial aquifer within 30 years, 2. Meet MCLs for VOCs in Magothy aquifer within 65 years, 3. Meet MCLs for Sr-90 in Upper Glacial aquifer within 40 years and 70 years at Chemical Holes and BGRR/WCF plumes, respectively.
	Tetrachloroethylene			5 µg/L		
	Carbon tetrachloride			5 µg/L		
	Tritium			20,000 pCi/L		
	Strontium-90			8 pCi/L		
	PCBs	1 mg/kg - Surface NYSDEC TAGM	10 mg/kg - Subsurf. NYSDEC TAGM			
IV	Ethylbenzene			5 µg/L		Restore groundwater quality to MCLs or background, and prevent or minimize: 1. Leaching of contaminants from soil into groundwater, 2. Human exposure from surface and subsurface soil, 3, Uptake of contaminants in soil by plants and animals.
	Toluene			5 µg/L		
	Strontium-90			8 pCi/L		
V	Mercury	2 mg/kg				Protect public health and the sole source aquifer, monitor the groundwater, and prevent
	Cesium-137	23 pCi/g				

Attachment 5
Operable Unit Cleanup Levels Matrix

Operable Unit	Contaminants of Concern	Cleanup Levels			Note any Changes to Cleanup Levels	Remedial Action Objectives
	Trichloroethene			5 µg/L		or minimize: 1. Migration of contaminants present in surface soil via surface runoff, 2. Human and environmental exposure from surface and subsurface soil. 3. Reduce site-related contaminants (e.g., mercury) in sediment to levels that are protective of human health, 4. Reduce or mitigate, to the extent practicable, existing and potential adverse ecological effects of contaminants in the Peconic River, 5. Prevent or reduce the migration of contaminants off the BNL property.
VI	Ethylene dibromide			0.05 µg/L		1. Meet MCLs for EDB in the Upper Glacial aquifer within 30 years, 2. Prevent or minimize further migration of EDB in groundwater vertically and horizontally.
BGRR	Strontium-90	ALARA (1)	ALARA	8 pCi/L		1. Ensure protection of human health and the environment from the potential hazards posed by the radiological inventory that resides in the BGRR complex, 2. Use ALARA while implementing the remedial action, 3. Implement long-term monitoring, maintenance, and institutional controls to manage potential hazards.
	Cesium-137	ALARA	ALARA			

(1) ALARA - as low as reasonably achievable.

Attachment 6

Soil Vapor Intrusion Screenings

Environmental & Waste Management Services Division

BROOKHAVEN
NATIONAL LABORATORY

Building 51
P.O. Box 5000
Upton, NY 11973-5000
Phone 631 344-5588
Fax 631 344-7776
howe@bnl.gov

managed by Brookhaven Science Associates
for the U.S. Department of Energy

Memo

date: *August 21, 2008*

to: *File*

from: *R. Howe* R Howe

subject: SOIL GAS VAPOR EVALUATION FOR NEW WAREHOUSE

This memo documents the potential for soil gas vapor buildup in the new Warehouse (Bldg. 98) that was recently constructed. As identified in the attached preliminary initial screening for this building, the closest groundwater contaminant plume is approximately 200 feet to the west and this facility has no basement. Therefore, the subsurface to indoor air pathway is incomplete, and no further evaluation is needed at this time.

Attachment

Copy: J. Burke
M. Davis
W. Dorsch
G. Penny
V. Racaniello
File: GWER 59.08

T:\LTRA\SoilT:\LTRA\Soil Vapor\Soil Vapor Eval Memo B98 08-21-08.doc

FOR New Warehouse - Bldg. 98 8/21/08
Soil Vapor Evaluation

IV. TIER 1 - Primary Screening

Primary Screening is designed to help quickly screen out sites at which the vapor intrusion pathway does not ordinarily need further consideration, and point out the sites that do typically need further consideration. This evaluation involves determining whether any potential exists at a specific site for vapor intrusion to result in unacceptable indoor inhalation risks and, if so, whether immediate action may be warranted. Recommended criteria for making these determinations are presented in Questions 1 through 3, which focus on identifying:

a) if chemicals of sufficient volatility and toxicity are present or reasonably suspected to be present (Question 1);
b) if inhabited buildings are located (or will be constructed under future development scenarios – except for Environmental Indicator determinations, see section IV.C below) above or in close proximity to subsurface contamination (Question 2); and
c) if current conditions warrant immediate action (Question 3).

This primary screening process is illustrated in a flow diagram included in Appendix C.

A. Primary Screening – Question #1

Q1: Are chemicals of sufficient volatility and toxicity known or reasonably suspected to be present in the subsurface (e.g., in unsaturated soils, soil gas, or the uppermost portions of the ground water and/or capillary fringe – see Table 1)? (We recommend this consideration involve DQOs (see Appendix A) used in acquiring the site data as well as an appropriately scaled Conceptual Site Model (CSM) for vapor intrusion (see Appendix B).)

______ If **YES** - check here, check off the relevant chemicals on Table 1, and continue with Question 2. The chemicals identified here (and any degradation products) are evaluated as constituents of potential concern in subsequent questions.

__✓__ If **NO** - check here, provide the rationale and references below, and then go to the Summary Page to document that the subsurface vapor to indoor air pathway is incomplete (i.e., no further consideration of this pathway is needed); or

______ If sufficient data are not available, go to the Summary Page and document the need for more information. After collecting the necessary data, Question 1 can then be revisited with the newly collected data to re-evaluate the completeness of the vapor intrusion pathway.

1. What is the goal of this question?

This question is designed to help quickly screen out sites at which the vapor intrusion pathway generally does not need further consideration. This evaluation involves determining whether or not any potential exists at a specific site for the vapor intrusion

pathway to result in unacceptable indoor air inhalation risks. Table 1 lists chemicals that may be found at hazardous waste sites and indicates whether, in our judgment, they are sufficiently volatile (Henry's Law Constant > 10^{-5} atm m^3/mol) to result in potentially significant vapor intrusion and sufficiently toxic (either an incremental lifetime cancer risk greater than 10^{-6} or a non-cancer hazard index greater than 1, or in some cases both) to result in potentially unacceptable indoor air inhalation risks. The approach used to develop Table 1 is documented in Appendix D and can be used, where appropriate, to evaluate volatile chemicals not included in the Table. We recommend that if any of the chemicals listed in Table 1 that are sufficiently volatile and toxic are present at a site, those chemicals become constituents of potential concern for the vapor intrusion pathway and are evaluated in subsequent questions in this guidance. If the chemicals listed in Table 1 are not present at a site, and no other volatile chemicals are present, we suggest that the vapor intrusion pathway be considered incomplete and no further consideration of this pathway is needed.

2. *What should you keep in mind?*

In evaluating the available site data, we recommend the DQOs used in collecting the data be reviewed to ensure those objectives are consistent with the DQOs for the vapor intrusion pathway (see Appendix A). We recommend the detection limits associated with the available groundwater data be reviewed to ensure they are not too high to detect volatile contaminants of potential concern. Also, we suggest that the adequacy of the definition of the nature and extent of contamination in groundwater and/or the vadose zone be assessed to ensure that all contaminants of concern and areas of contamination have been identified. Additionally, we recommend groundwater concentrations be measured or reasonably estimated using samples collected from wells screened at, or across the top of the water table. We recommend users read Appendices B (Conceptual Site Model for the Vapor Intrusion Pathway) and E (Relevant Methods and Techniques) to obtain a greater understanding of the important considerations in evaluating data for use in screening assessments of the vapor intrusion pathway.

3. *Rationale and References:*

The carbon tetrachloride plume is the closest VOC contamination to Bldg. 98. The closest monitoring well is ~400 feet away and the carbon tetrachloride concentrations are less than the Table 2 criteria (i.e. MCL). Therefore the chemicals are not of sufficient volatility. (see attached analytical data + figure)

B. Primary Screening – Question #2

Q2: Are currently (or potentially) inhabited buildings or areas of concern under future development scenarios located *near* (see discussion below) subsurface contaminants found in Table 1?

_____ If **YES** – check here, identify buildings and/or areas of concern below, and document on the Summary Page whether the potential for impacts from the vapor intrusion pathway applies to currently inhabited buildings or areas of concern under reasonably anticipated future development scenarios, or both. (Note that for EI considerations, we recommend only current risks be evaluated.) Then proceed with Question 3.

__✓__ If **NO** – check here, describe the rationale below, and then go to the Summary Page to document that there is no potential for the vapor intrusion pathway to impact either currently inhabited buildings or areas of concern under future development scenarios (i.e., no further evaluation of this pathway is needed). (Note that for EI considerations, only current risks are evaluated.); or

_____ If sufficient data are not available – check here and document the need for more information on the Summary Page. After collecting the necessary data, Question 2 can then be revisited with the newly collected data to re-evaluate the completeness of the vapor intrusion pathway.

1. What is the goal of this question?

The goal of this question is to help determine whether inhabited buildings currently are located (or may be reasonably expected to be located under future development scenarios) above or in close proximity to subsurface contamination that potentially could result in unacceptable indoor air inhalation risks. If inhabited buildings and/or future development are not located "near" the area of concern, we suggest that the vapor intrusion pathway be considered incomplete and no further consideration of the pathway should be needed.

For the purposes of this question, "**inhabited buildings**" are structures with enclosed air space that are designed for human occupancy. Table I, discussed above in Question 1, lists the "**subsurface contaminants demonstrating sufficient volatility and toxicity**" to potentially pose an inhalation risk. We recommend that an inhabited building generally be considered "**near**" subsurface contaminants if it is located within approximately 100 ft laterally or vertically of known or interpolated soil gas or groundwater contaminants listed in Table 1 (or others not included in table 1 – see Question 1) and the contamination occurs in the unsaturated zone and/or the uppermost saturated zone. If the source of contamination is groundwater, we recommend migration of the contaminant plume be considered when evaluating the potential for future risks. The distance suggested above (100 feet) may not be appropriate for all sites (or contaminants) and, consequently, we recommend that professional judgment be used when evaluating the potential for vertical and horizontal vapor migration.

2. How did we develop the suggested distance?

The recommended distance is designed to allow for the assessment to focus on buildings (or areas with the potential to be developed for human habitation) most likely to have a complete vapor intrusion pathway. Vapor concentrations generally decrease with increasing distance from a subsurface vapor source, and eventually at some distance the concentrations become negligible. The distance at which concentrations are negligible is a function of the mobility, toxicity and persistence of the chemical, as well as the geometry of the source, subsurface materials, and characteristics of the buildings of concern. Available information suggests that 100 feet laterally and vertically is a reasonable criterion when considering vapor migration fundamentals, typical sampling density, and uncertainty in defining the actual contaminant spatial distribution. The recommended lateral distance is supported by empirical data from Colorado sites where the vapor intrusion pathway has been evaluated. At these sites, no significant indoor air concentrations have been found in residences at a distance greater than one house lot (approximately 100 feet) from the interpolated edge of ground water plumes. Considering the nature of diffusive vapor transport and the typical anisotropy in soil permeability, in our judgment a similar criterion of 100 feet for vertical transport is generally conservative. These recommended distances will be re-evaluated and, if necessary, adjusted by EPA as additional empirical data are compiled.

3. What should you keep in mind when evaluating this criterion?

It is important to consider whether **significant preferential pathways** could allow vapors to migrate more than 100 feet laterally. For the purposes of this guidance, a "significant" preferential pathway is a naturally occurring or anthropogenic subsurface pathway that is expected to have a high gas permeability and be of sufficient volume and proximity to a building so that it may be reasonably anticipated to influence vapor intrusion into the building. Examples include fractures, macropores, utility conduits, and subsurface drains that intersect vapor sources or vapor migration pathways. Note that naturally occurring fractures and macropores may serve as preferential pathways for either vertical or horizontal vapor migration, whereas anthropogenic features such as utility conduits are relatively shallow features and would likely serve only as a preferential pathway for horizontal migration. In either case, we recommend that buildings with significant preferential pathways be evaluated even if they are further than 100 ft from the contamination.

We also recommend that the potential for mobile "vapor clouds" (gas plumes) emanating from near-surface sources of contamination into the subsurface be considered when evaluating site data. Examples of such mobile "vapor clouds" include: 1) those originating in landfills where methane may serve as a carrier gas; and 2) those originating in commercial/industrial settings (such as dry cleaning facilities) where vapor can be released within an enclosed space and the density of the chemicals' vapor may result in

significant advective transport of the vapors downward through cracks/openings in floors and into the vadose zone. In these cases, diffusive transport of vapors is usually overridden by advective transport, and the vapors may be transported in the vadose zone several hundred feet from the source of contamination.

Finally, this guidance is intended to be applied to existing groundwater plumes as they are currently defined (e.g., MCLs, State Standards, or Risk-Based Concentrations). However, it is very important to recognize that some non-potable aquifers may have plumes that have been defined by threshold concentrations significantly higher than drinking-water concentrations. In these cases, contamination that is not technically considered part of the plume may still pose significant risks via the vapor intrusion pathway and, consequently, the plume definition may need to be expanded. Similarly, we recommend evaluating the technologies used to obtain soil gas and indoor air concentrations to determine if appropriate methods were used to ensure adequate data quality at the time analyses were conducted.

4. ***Identify Inhabited Buildings (or Areas With Potential for Future Residential Development) Within Distances of Possible Concern:***

The new Warehouse (Bldg 98) is located >200 feet from the portion of the carbon tetrachloride plume exceeding the standard (i.e. MCL). The warehouse is used for storage and the office trailers are used by workers only during the day. The building does not have a basement.

C. Primary Screening Stage— Question #3

Q3: Does evidence suggest immediate action may be warranted to mitigate current risks?

______ If **YES** – check here and proceed with appropriate actions to verify or eliminate imminent risks. Some examples of actions may include but are not limited to indoor air quality monitoring, engineered containment or ventilation systems, or relocation of people. The action(s) should be appropriate for the site-specific situation.

__✓__ If **NO** – check here and continue with Question 4.

1. What is the goal of this question?

This question is intended to help determine whether immediate action may be warranted for those buildings identified in Question 2 as located within the areas of concern. For the purposes of this guidance, "immediate action" means such action is necessary to verify or abate imminent and substantial threats to human health.

2. What are the qualitative criteria generally considered sufficient to indicate a need for immediate actions?

Odors reported by occupants, particularly if described as "chemical," or "solvent," or "gasoline." The presence of odors does not necessarily correspond to adverse health and/or safety impacts and the odors could be the result of indoor vapor sources; however, we believe it is generally prudent to investigate any reports of odors as the odor threshold for some chemicals exceeds their respective acceptable target breathing zone concentrations.

Physiological effects reported by occupants (dizziness, nausea, vomiting, confusion, etc.) may, or may not be due to subsurface vapor intrusion or even other indoor vapor sources, but, should generally be evaluated.

Wet basements, in areas **where chemicals of sufficient volatility and toxicity** (see Table 1) **are known to be present in groundwater and the water table is shallow enough that the basements are prone to groundwater intrusion or flooding.** This has been proven to be especially important where there is evidence of light, non-aqueous phase liquids (LNAPLs) floating on the water table directly below the building, and/or any direct evidence of contamination (liquid chemical or dissolved in water) inside the building.

Short-term safety concerns are known, or are reasonably suspected to exist, including: a) measured or likely explosive or acutely toxic concentrations of vapors in the building or connected utility conduits, sumps, or other subsurface drains directly connected to the

building and b) measured or likely vapor concentrations that may be flammable/combustible, corrosive, or chemically reactive.

3. *Rationale and Reference(s):*

None. No basement in Bldg. 98

VII. VAPOR INTRUSION PATHWAY SUMMARY PAGE

Facility Name: Warehouse (Bldg. 98)

Facility Address: Rochester St. and S. Harvard St. - BNL.

Primary Screening Summary

☐ *Q1: Constituents of concern Identified?*

_____ *Yes*

__✓__ *No* (If NO, skip to the conclusion section below and check NO to indicate the pathway is *incomplete.)*

☐ *Q2: Currently inhabited buildings near subsurface contamination?*

_____ *Yes*

__✓__ *No*

Areas of future concern near subsurface contamination?

_____ *Yes*

__✓__ *No* (If NO, skip to the conclusion section below and check NO to indicate the pathway is *incomplete.)*

☐ *Q3: Immediate Actions Warranted?*

_____ *Yes*

__✓__ *No*

Secondary Screening Summary

☐ *Vapor source identified:*

_____ *Groundwater*

_____ *Soil*

_____ *Insufficient data*

☐ *Indoor air data available?*

_____ *Yes*

_____ *No*

☐ *Indoor air concentrations exceed target levels?*

_____ *Yes*

_____ *No*

☐ *Subsurface data evaluation: (Circle appropriate answers below)*

Medium	Q4 Levels Exceeded?	Q5 Levels Exceeded?	Data Indicates Pathway is Complete?
Groundwater	YES / NO / NA / INS	YES / NO / NA / INS	YES / NO / INS
Soil Gas	YES / NO / NA / INS	YES / NO / NA / INS	YES / NO / INS

NA = not applicable
INS = insufficient data available to make a determination

Site-Specific Summary

☐ *Have the nature and extent of subsurface contamination, potential preferential pathways and overlying building characteristics been adequately characterized to identify the most-likely-to-be-impacted buildings?*

_____ *Yes*

_____ *No*

_____ *N/A*

EPA recommends that if a model was used, it be an appropriate and applicable model that represents the conceptual site model. If other means were used, document how you determined the potentially most impacted areas to sample. EPA recommends that predictive modeling can be used to support Current Human Exposures Under Control EI determinations without confirmatory sampling to support this determination. Current Human Exposures Under Control EI determinations are intended to reflect a reasonable conclusion by EPA or the State that current human exposures are under control with regard to the vapor intrusion pathway and current land use conditions. Therefore, if conducting evaluation for an EI determination, document that the **Pathway is Incomplete** and/or does not pose an unacceptable risk to human health for EI determinations.

☐ *Are you making an EI determination based on modeling and does the model prediction indicate that determination is expected to be adequately protective to support Current Human Exposures Under Control EI determinations?*

_____ *Yes*

_____ *No*

_____ *N/A*

☐ *Do subslab vapor concentrations exceed target levels?*

_____ *Yes*

_____ *No*

_____ *N/A*

☐ *Do indoor air concentrations exceed target levels?*

_____ *Yes*

_____ *No*

Conclusion

Is there a Complete Pathway for subsurface vapor intrusion to indoor air?

Below, check the appropriate conclusion for the Subsurface Vapor to Indoor Air Pathway evaluation and attach supporting documentation as well as a map of the facility.

✓ NO - the "Subsurface Vapor Intrusion to Indoor Air Pathway" has been verified to be incomplete for the Warehouse (Bldg. 98) facility, EPA ID # _____________, located at BNL. This determination is based on a review of site information, as suggested in this guidance, check as appropriate:

✓ for current and reasonably expected conditions, or

_____ based on performance monitoring evaluations for engineered exposure controls. This determination may be re-evaluated, where appropriate, when the Agency/State becomes aware of any significant changes at the facility.

_____ YES –The "Subsurface Vapor to Indoor Air Pathway" is Complete. Engineered controls, avoidance actions, or removal actions taken include: _____________

_____ UNKNOWN - More information is needed to make a determination.

Locations where References may be found:

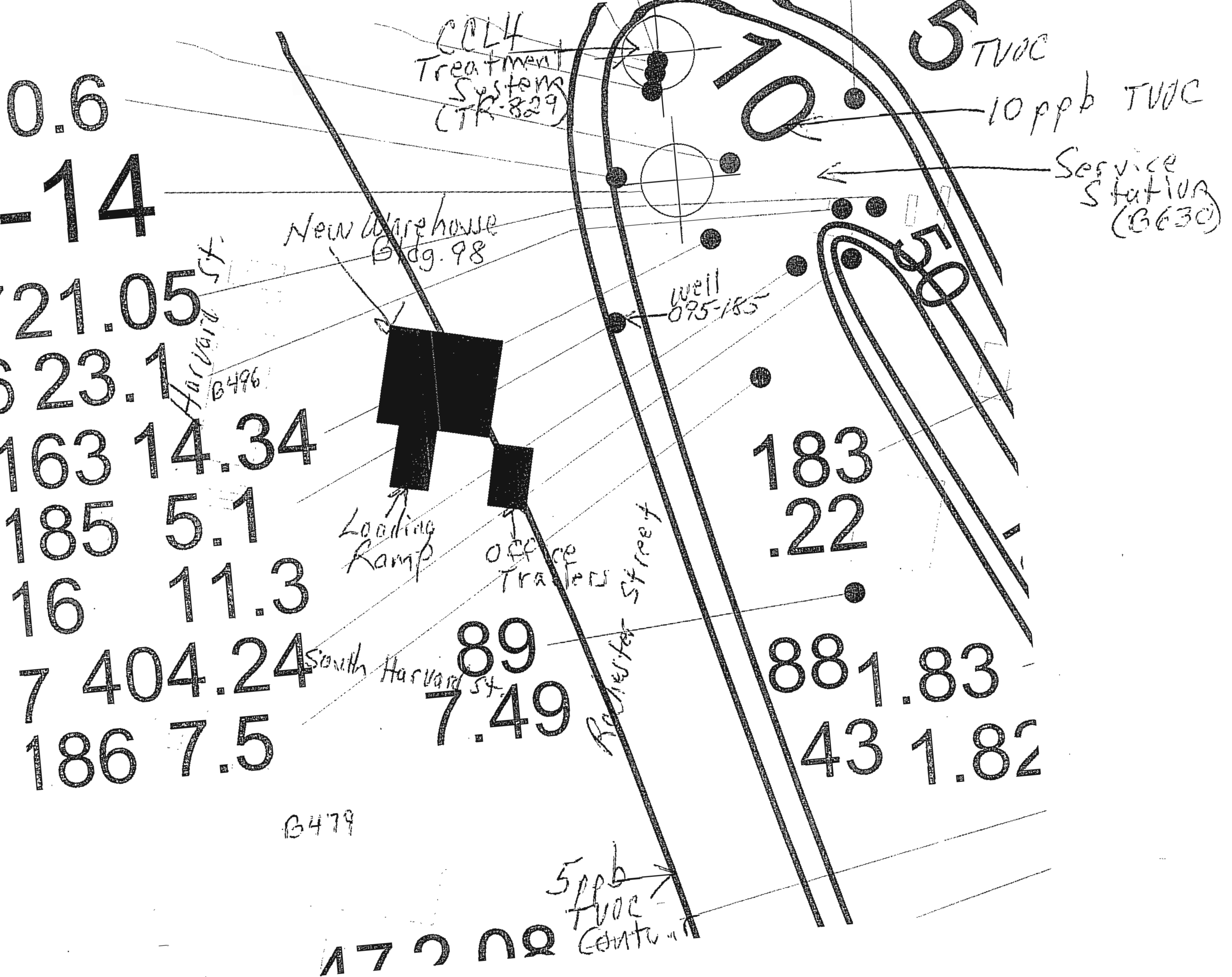
See attached

Contact telephone and e-mail numbers:

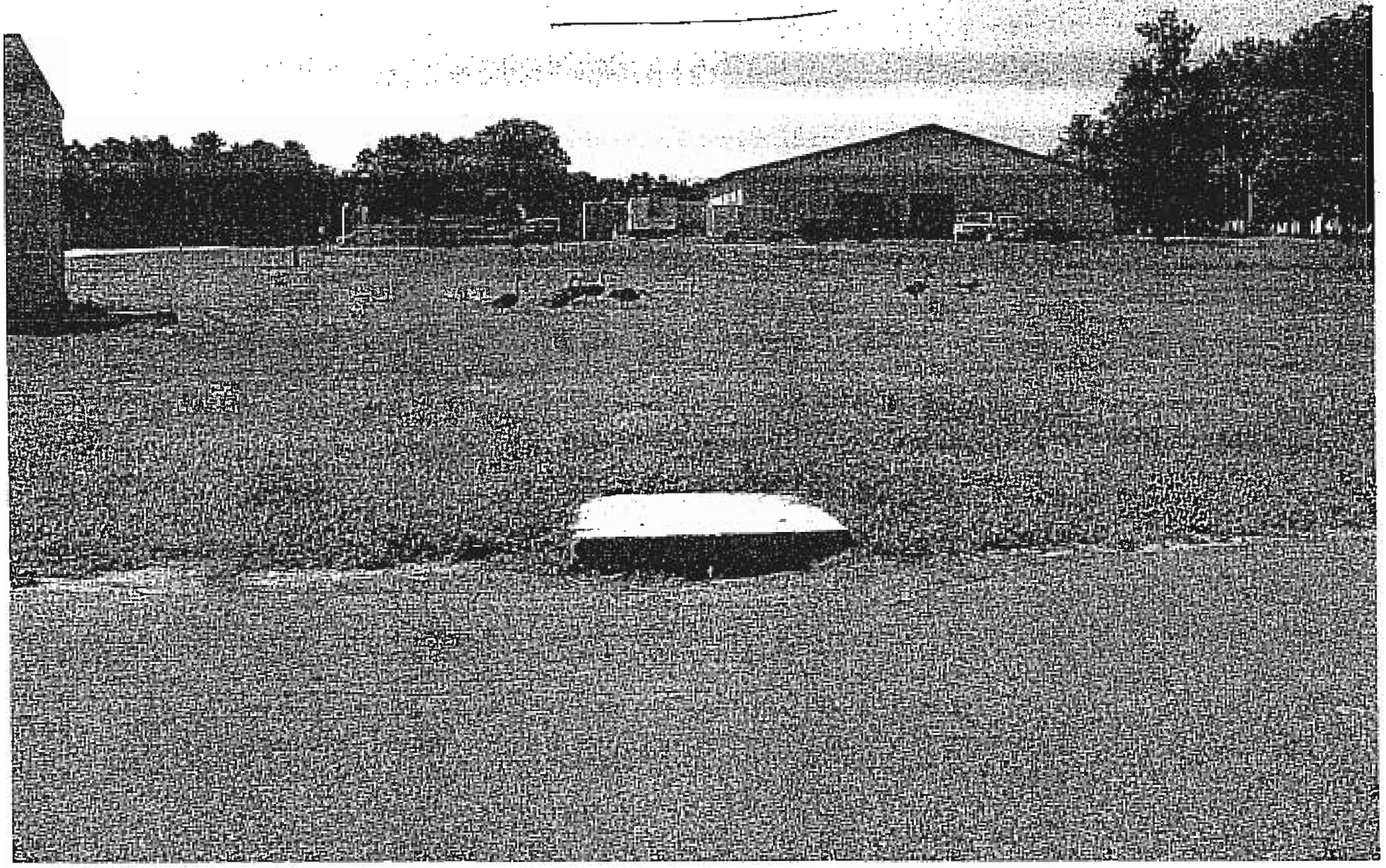
(name) Bob Howe R Howe 8/21/08

(phone #) 344-5588

(e-mail) howe@bnl.gov


5 TVOC
10
10ppb TVOC
CCL4 Treatment Systems (TK-829)
Service Station (G630)
50
0.6
-14
New Warehouse Bldg. 98
Well 095-185
21.05
23.1
Harvard St.
B496
163 14.34
183
.22
185 5.1
Loading Ramp
Office Trailers
Rochester Street
16 11.3
7 404.24
South Harvard St.
89
7.49
88 1.83
186 7.5
43 1.82
B479
5ppb TVOC Contour
47 2.08

New Warehouse
Bldg. 98



New Warehouse (Bldg. 98) Nearby Monitoring Well Data (8/21/08)

Site ID: 095-185

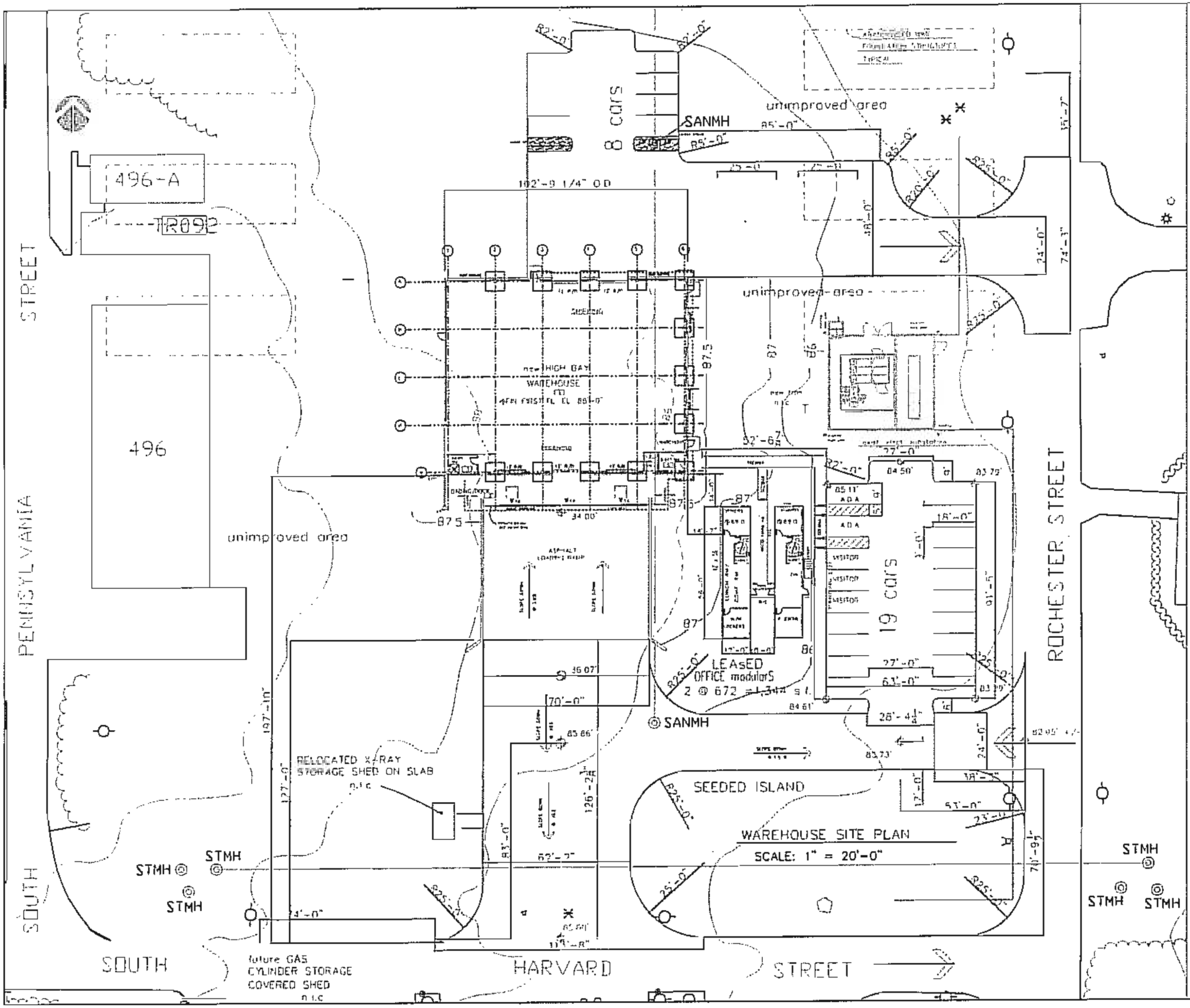
Chemical Name	**Sample Date**	**Value**	**Det. Limit**	**Error**	**Units**	**Depth**	**Qual.**
524.2 TVOC	1/30/2006	4.42	--	--	UG/L	47	
Carbon tetrachloride	1/30/2006	3.7	0.5	--	UG/L	47	
Chloroform	1/30/2006	0.72	0.5	--	UG/L	47	
524.2 TVOC	4/28/2006	3.94	--	--	UG/L	47	
Carbon tetrachloride	4/28/2006	3.3	0.5	--	UG/L	47	
Chloroform	4/28/2006	0.64	0.5	--	UG/L	47	
524.2 TVOC	7/26/2006	6.13	--	--	UG/L	47	
Carbon tetrachloride	7/26/2006	5.3	0.5	--	UG/L	47	
Chloroform	7/26/2006	0.83	0.5	--	UG/L	47	
524.2 TVOC	10/16/2006	4.78	--	--	UG/L	47.5	
Carbon tetrachloride	10/16/2006	4.1	0.5	--	UG/L	47.5	
Chloroform	10/16/2006	0.68	0.5	--	UG/L	47.5	
524.2 TVOC	1/12/2007	6.1	--	--	UG/L	47	
Carbon tetrachloride	1/12/2007	4.9	0.5	--	UG/L	47	
Chloroform	1/12/2007	1.2	0.5	--	UG/L	47	
524.2 TVOC	4/11/2007	3.38	--	--	UG/L	47	
Carbon tetrachloride	4/11/2007	2.7	0.5	--	UG/L	47	
Chloroform	4/11/2007	0.68	0.5	--	UG/L	47	
524.2 TVOC	10/12/2007	5.1	--	--	UG/L	45	
Carbon tetrachloride	10/12/2007	3.8	0.5	--	UG/L	45	
Chloroform	10/12/2007	1.3	0.5	--	UG/L	45	
524.2 TVOC	6/17/2008	1.79	--	--	UG/L	47	
Carbon tetrachloride	6/17/2008	1.2	0.5	--	UG/L	47	
Chloroform	6/17/2008	0.59	0.5	--	UG/L	47	

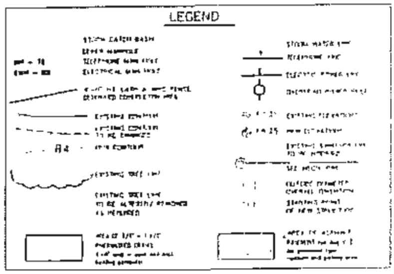
Site ID: 095-89

Chemical Name	**Sample Date**	**Value**	**Det. Limit**	**Error**	**Units**	**Depth**	**Qual.**
1,1,1-Trichloroethane	1/27/2006	2.8	0.5	--	UG/L	160	
1,1-Dichloroethane	1/27/2006	0.49	0.5	--	UG/L	160	J
1,1-Dichloroethylene	1/27/2006	1.4	0.5	--	UG/L	160	
524.2 TVOC	1/27/2006	7.569	--	--	UG/L	160	
Carbon tetrachloride	1/27/2006	0.29	0.5	--	UG/L	160	J
Chloroform	1/27/2006	2	0.5	--	UG/L	160	
Trichloroethylene	1/27/2006	0.5	0.5	--	UG/L	160	
Trichlorofluoromethane	1/27/2006	0.089	0.5	--	UG/L	160	J
1,1,1-Trichloroethane	4/27/2006	3.1	0.5	--	UG/L	160	
1,1-Dichloroethane	4/27/2006	0.48	0.5	--	UG/L	160	J
1,1-Dichloroethylene	4/27/2006	1.5	0.5	--	UG/L	160	
524.2 TVOC	4/27/2006	8.02	--	--	UG/L	160	
Carbon tetrachloride	4/27/2006	0.24	0.5	--	UG/L	160	J
Chloroform	4/27/2006	2.2	0.5	--	UG/L	160	
Trichloroethylene	4/27/2006	0.5	0.5	--	UG/L	160	
1,1,1-Trichloroethane	8/8/2006	2.8	0.5	--	UG/L	160	
1,1-Dichloroethane	8/8/2006	0.43	0.5	--	UG/L	160	J
1,1-Dichloroethylene	8/8/2006	1.2	0.5	--	UG/L	160	
524.2 TVOC	8/8/2006	7.83	--	--	UG/L	160	
Carbon tetrachloride	8/8/2006	0.37	0.5	--	UG/L	160	J
Chloroform	8/8/2006	2.6	0.5	--	UG/L	160	
Trichloroethylene	8/8/2006	0.43	0.5	--	UG/L	160	J
1,1,1-Trichloroethane	10/17/2006	2.6	0.5	--	UG/L	160	

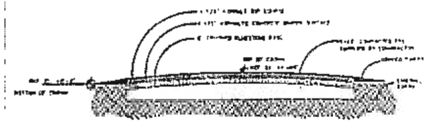
New Warehouse (Bldg. 98) Nearby Monitoring Well Data (8/21/08)

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
1,1-Dichloroethane	10/17/2006	0.38	0.5	--	UG/L	160	J
1,1-Dichloroethylene	10/17/2006	1.2	0.5	--	UG/L	160	
524.2 TVOC	10/17/2006	7.87	--	--	UG/L	160	
Carbon tetrachloride	10/17/2006	0.57	0.5	--	UG/L	160	
Chloroform	10/17/2006	2.7	0.5	--	UG/L	160	
Trichloroethylene	10/17/2006	0.42	0.5	--	UG/L	160	J
1,1,1-Trichloroethane	1/12/2007	1.8	0.5	--	UG/L	160	
1,1-Dichloroethylene	1/12/2007	0.97	0.5	--	UG/L	160	
524.2 TVOC	1/12/2007	5.58	--	--	UG/L	160	
Carbon tetrachloride	1/12/2007	0.71	0.5	--	UG/L	160	
Chloroform	1/12/2007	2.1	0.5	--	UG/L	160	
1,1,1-Trichloroethane	4/11/2007	1.8	0.5	--	UG/L	160	
1,1-Dichloroethane	4/11/2007	0.35	0.5	--	UG/L	160	J
1,1-Dichloroethylene	4/11/2007	0.88	0.5	--	UG/L	160	
524.2 TVOC	4/11/2007	5.85	--	--	UG/L	160	
Carbon tetrachloride	4/11/2007	0.3	0.5	--	UG/L	160	J
Chloroform	4/11/2007	2.2	0.5	--	UG/L	160	
Trichloroethylene	4/11/2007	0.32	0.5	--	UG/L	160	J
1,1,1-Trichloroethane	10/12/2007	1.9	0.5	--	UG/L	160	
1,1-Dichloroethane	10/12/2007	0.48	0.5	--	UG/L	160	J
1,1-Dichloroethylene	10/12/2007	0.93	0.5	--	UG/L	160	
524.2 TVOC	10/12/2007	7.49	--	--	UG/L	160	
Carbon tetrachloride	10/12/2007	0.72	0.5	--	UG/L	160	
Chloroform	10/12/2007	3.1	0.5	--	UG/L	160	
Trichloroethylene	10/12/2007	0.36	0.5	--	UG/L	160	J
1,1,1-Trichloroethane	4/15/2008	1.6	0.5	--	UG/L	160	
1,1-Dichloroethane	4/15/2008	0.54	0.5	--	UG/L	160	
1,1-Dichloroethylene	4/15/2008	0.86	0.5	--	UG/L	160	
524.2 TVOC	4/15/2008	7.17	--	--	UG/L	160	
Carbon tetrachloride	4/15/2008	0.64	0.5	--	UG/L	160	
Chloroform	4/15/2008	3.2	0.5	--	UG/L	160	
Trichloroethylene	4/15/2008	0.33	0.5	--	UG/L	160	J





STAGING, EXCAVATION, BACK FILL PAVING NOTES



SECTION A-A ROAD PROFILE - TYPICAL

SCALE 1" = 5'-0"

CONSTRUCTION SET

BROOKHAVEN
NATIONAL LABORATORY

UNDER CONTRACT WITH
UNITED STATES DEPARTMENT OF ENERGY
PLANT ENGINEERING DIVISION
UPTON, NEW YORK 11973

MATERIALS HANDLING FACILITY
NEW WAREHOUSE

SITE PLAN
SOUTH OF 1453

Environmental & Waste Management Services Division

BROOKHAVEN
NATIONAL LABORATORY

Building 51
P.O. Box 5000
Upton, NY 11973-5000
Phone 631 344-5588
Fax 631 344-7776
howe@bnl.gov

managed by Brookhaven Science Associates
for the U.S. Department of Energy

Memo

date: *June 5, 2008*

to: *File*

from: *R. Howe* R Howe

subject: SOIL GAS VAPOR EVALUATION FOR NEW BUILDING

This memo documents the potential for soil gas vapor buildup in the proposed Interdisciplinary Science Building (ISB) at BNL that is currently in the planning stage. As identified in the attached preliminary initial screening for this building, the closest groundwater contaminant plume is approximately 500 feet to the southwest. In addition, a clean layer of groundwater exists above this plume. Therefore, the subsurface to indoor air pathway is incomplete, and no further evaluation is needed at this time.

Attachment

Copy: M. Davis
W. Dorsch
G. Penny
File: GWER 59.08

Registered to ISO 14001

T:\LTRA\Soil Vapor\Soil Vapor Eval Memo 060408.doc

6/4/08

FOR Interdisciplinary Science Bldg (ISB) Soil Vapor Evaluation

IV. TIER 1 - Primary Screening

Primary Screening is designed to help quickly screen out sites at which the vapor intrusion pathway does not ordinarily need further consideration, and point out the sites that do typically need further consideration. This evaluation involves determining whether any potential exists at a specific site for vapor intrusion to result in unacceptable indoor inhalation risks and, if so, whether immediate action may be warranted. Recommended criteria for making these determinations are presented in Questions 1 through 3, which focus on identifying:

a) if chemicals of sufficient volatility and toxicity are present or reasonably suspected to be present (Question 1);
b) if inhabited buildings are located (or will be constructed under future development scenarios – except for Environmental Indicator determinations, see section IV.C below) above or in close proximity to subsurface contamination (Question 2); and
c) if current conditions warrant immediate action (Question 3).

This primary screening process is illustrated in a flow diagram included in Appendix C:

A. Primary Screening – Question #1

Q1: Are chemicals of sufficient volatility and toxicity known or reasonably suspected to be present in the subsurface (e.g., in unsaturated soils, soil gas, or the uppermost portions of the ground water and/or capillary fringe – see Table 1)? (We recommend this consideration involve DQOs (see Appendix A) used in acquiring the site data as well as an appropriately scaled Conceptual Site Model (CSM) for vapor intrusion (see Appendix B).)

_____ If **YES** - check here, check off the relevant chemicals on Table 1, and continue with Question 2. The chemicals identified here (and any degradation products) are evaluated as constituents of potential concern in subsequent questions.

✓ If **NO** - check here, provide the rationale and references below, and then go to the Summary Page to document that the subsurface vapor to indoor air pathway is incomplete (i.e., no further consideration of this pathway is needed); or

_____ If sufficient data are not available, go to the Summary Page and document the need for more information. After collecting the necessary data, Question 1 can then be revisited with the newly collected data to re-evaluate the completeness of the vapor intrusion pathway.

1. What is the goal of this question?

This question is designed to help quickly screen out sites at which the vapor intrusion pathway generally does not need further consideration. This evaluation involves determining whether or not any potential exists at a specific site for the vapor intrusion

pathway to result in unacceptable indoor air inhalation risks. Table 1 lists chemicals that may be found at hazardous waste sites and indicates whether, in our judgment, they are sufficiently volatile (Henry's Law Constant > 10^{-5} atm m^3/mol) to result in potentially significant vapor intrusion and sufficiently toxic (either an incremental lifetime cancer risk greater than 10^{-6} or a non-cancer hazard index greater than 1, or in some cases both) to result in potentially unacceptable indoor air inhalation risks. The approach used to develop Table 1 is documented in Appendix D and can be used, where appropriate, to evaluate volatile chemicals not included in the Table. We recommend that if any of the chemicals listed in Table 1 that are sufficiently volatile and toxic are present at a site, those chemicals become constituents of potential concern for the vapor intrusion pathway and are evaluated in subsequent questions in this guidance. If the chemicals listed in Table 1 are not present at a site, and no other volatile chemicals are present, we suggest that the vapor intrusion pathway be considered incomplete and no further consideration of this pathway is needed.

2. *What should you keep in mind?*

In evaluating the available site data, we recommend the DQOs used in collecting the data be reviewed to ensure those objectives are consistent with the DQOs for the vapor intrusion pathway (see Appendix A). We recommend the detection limits associated with the available groundwater data be reviewed to ensure they are not too high to detect volatile contaminants of potential concern. Also, we suggest that the adequacy of the definition of the nature and extent of contamination in groundwater and/or the vadose zone be assessed to ensure that all contaminants of concern and areas of contamination have been identified. Additionally, we recommend groundwater concentrations be measured or reasonably estimated using samples collected from wells screened at, or across the top of the water table. We recommend users read Appendices B (Conceptual Site Model for the Vapor Intrusion Pathway) and E (Relevant Methods and Techniques) to obtain a greater understanding of the important considerations in evaluating data for use in screening assessments of the vapor intrusion pathway.

3. *Rationale and References:*

No plumes in groundwater exist in the area of the proposed ISB. There is clean groundwater across the top of the water table (See location figure)

B. Primary Screening – Question #2

Q2: Are currently (or potentially) inhabited buildings or areas of concern under future development scenarios located *near* (see discussion below) subsurface contaminants found in Table 1?

_____ If **YES** – check here, identify buildings and/or areas of concern below, and document on the Summary Page whether the potential for impacts from the vapor intrusion pathway applies to currently inhabited buildings or areas of concern under reasonably anticipated future development scenarios, or both. (Note that for EI considerations, we recommend only current risks be evaluated.) Then proceed with Question 3.

✓ If **NO** – check here, describe the rationale below, and then go to the Summary Page to document that there is no potential for the vapor intrusion pathway to impact either currently inhabited buildings or areas of concern under future development scenarios (i.e., no further evaluation of this pathway is needed). (Note that for EI considerations, only current risks are evaluated.); or

_____ If sufficient data are not available – check here and document the need for more information on the Summary Page. After collecting the necessary data, Question 2 can then be revisited with the newly collected data to re-evaluate the completeness of the vapor intrusion pathway.

1. What is the goal of this question?

The goal of this question is to help determine whether inhabited buildings currently are located (or may be reasonably expected to be located under future development scenarios) above or in close proximity to subsurface contamination that potentially could result in unacceptable indoor air inhalation risks. If inhabited buildings and/or future development are not located "near" the area of concern, we suggest that the vapor intrusion pathway be considered incomplete and no further consideration of the pathway should be needed.

For the purposes of this question, **"inhabited buildings"** are structures with enclosed air space that are designed for human occupancy. Table 1, discussed above in Question 1, lists the **"subsurface contaminants demonstrating sufficient volatility and toxicity"** to potentially pose an inhalation risk. We recommend that an inhabited building generally be considered **"near"** subsurface contaminants if it is located within approximately 100 ft laterally or vertically of known or interpolated soil gas or groundwater contaminants listed in Table 1 (or others not included in table 1 – see Question 1) and the contamination occurs in the unsaturated zone and/or the uppermost saturated zone. If the source of contamination is groundwater, we recommend migration of the contaminant plume be considered when evaluating the potential for future risks. The distance suggested above (100 feet) may not be appropriate for all sites (or contaminants) and, consequently, we recommend that professional judgment be used when evaluating the potential for vertical and horizontal vapor migration.

2. How did we develop the suggested distance?

The recommended distance is designed to allow for the assessment to focus on buildings (or areas with the potential to be developed for human habitation) most likely to have a complete vapor intrusion pathway. Vapor concentrations generally decrease with increasing distance from a subsurface vapor source, and eventually at some distance the concentrations become negligible. The distance at which concentrations are negligible is a function of the mobility, toxicity and persistence of the chemical, as well as the geometry of the source, subsurface materials, and characteristics of the buildings of concern. Available information suggests that 100 feet laterally and vertically is a reasonable criterion when considering vapor migration fundamentals, typical sampling density, and uncertainty in defining the actual contaminant spatial distribution. The recommended lateral distance is supported by empirical data from Colorado sites where the vapor intrusion pathway has been evaluated. At these sites, no significant indoor air concentrations have been found in residences at a distance greater than one house lot (approximately 100 feet) from the interpolated edge of ground water plumes. Considering the nature of diffusive vapor transport and the typical anisotropy in soil permeability, in our judgment a similar criterion of 100 feet for vertical transport is generally conservative. These recommended distances will be re-evaluated and, if necessary, adjusted by EPA as additional empirical data are compiled.

3. What should you keep in mind when evaluating this criterion?

It is important to consider whether **significant preferential pathways** could allow vapors to migrate more than 100 feet laterally. For the purposes of this guidance, a "significant" preferential pathway is a naturally occurring or anthropogenic subsurface pathway that is expected to have a high gas permeability and be of sufficient volume and proximity to a building so that it may be reasonably anticipated to influence vapor intrusion into the building. Examples include fractures, macropores, utility conduits, and subsurface drains that intersect vapor sources or vapor migration pathways. Note that naturally occurring fractures and macropores may serve as preferential pathways for either vertical or horizontal vapor migration, whereas anthropogenic features such as utility conduits are relatively shallow features and would likely serve only as a preferential pathway for horizontal migration. In either case, we recommend that buildings with significant preferential pathways be evaluated even if they are further than 100 ft from the contamination.

We also recommend that the potential for mobile "vapor clouds" (gas plumes) emanating from near-surface sources of contamination into the subsurface be considered when evaluating site data. Examples of such mobile "vapor clouds" include: 1) those originating in landfills where methane may serve as a carrier gas; and 2) those originating in commercial/industrial settings (such as dry cleaning facilities) where vapor can be released within an enclosed space and the density of the chemicals' vapor may result in

significant advective transport of the vapors downward through cracks/openings in floors and into the vadose zone. In these cases, diffusive transport of vapors is usually overridden by advective transport, and the vapors may be transported in the vadose zone several hundred feet from the source of contamination.

Finally, this guidance is intended to be applied to existing groundwater plumes as they are currently defined (e.g., MCLs, State Standards, or Risk-Based Concentrations). However, it is very important to recognize that some non-potable aquifers may have plumes that have been defined by threshold concentrations significantly higher than drinking-water concentrations. In these cases, contamination that is not technically considered part of the plume may still pose significant risks via the vapor intrusion pathway and, consequently, the plume definition may need to be expanded. Similarly, we recommend evaluating the technologies used to obtain soil gas and indoor air concentrations to determine if appropriate methods were used to ensure adequate data quality at the time analyses were conducted.

4. *Identify Inhabited Buildings (or Areas With Potential for Future Residential Development) Within Distances of Possible Concern:*

IS6 - future potential building - outside of any contaminant plume. The subsurface vapor to indoor air pathway is incomplete and no further evaluation is needed at this time.

C. Primary Screening Stage— Question #3

Q3: Does evidence suggest immediate action may be warranted to mitigate current risks?

_____ If **YES** – check here and proceed with appropriate actions to verify or eliminate imminent risks. Some examples of actions may include but are not limited to indoor air quality monitoring, engineered containment or ventilation systems, or relocation of people. The action(s) should be appropriate for the site-specific situation.

✓ If **NO** – check here and continue with Question 4.

1. What is the goal of this question?

This question is intended to help determine whether immediate action may be warranted for those buildings identified in Question 2 as located within the areas of concern. For the purposes of this guidance, "immediate action" means such action is necessary to verify or abate imminent and substantial threats to human health.

2. What are the qualitative criteria generally considered sufficient to indicate a need for immediate actions?

Odors reported by occupants, particularly if described as "chemical," or "solvent," or "gasoline." The presence of odors does not necessarily correspond to adverse health and/or safety impacts and the odors could be the result of indoor vapor sources; however, we believe it is generally prudent to investigate any reports of odors as the odor threshold for some chemicals exceeds their respective acceptable target breathing zone concentrations.

Physiological effects reported by occupants (dizziness, nausea, vomiting, confusion, etc.) may, or may not be due to subsurface vapor intrusion or even other indoor vapor sources, but, should generally be evaluated.

Wet basements, in areas **where chemicals of sufficient volatility and toxicity** (see Table 1) **are known to be present in groundwater and the water table is shallow enough that the basements are prone to groundwater intrusion or flooding.** This has been proven to be especially important where there is evidence of light, non-aqueous phase liquids (LNAPLs) floating on the water table directly below the building, and/or any direct evidence of contamination (liquid chemical or dissolved in water) inside the building.

Short-term safety concerns are known, or are reasonably suspected to exist, including: a) measured or likely explosive or acutely toxic concentrations of vapors in the building or connected utility conduits, sumps, or other subsurface drains directly connected to the

building and b) measured or likely vapor concentrations that may be flammable/combustible, corrosive, or chemically reactive.

3. ***Rationale and Reference(s):***

None

VII. VAPOR INTRUSION PATHWAY SUMMARY PAGE

Facility Name: Interdisciplinary Science Bldg (ISB)
Facility Address: Brookhaven Ave. BNL

Primary Screening Summary

☐ *Q1: Constituents of concern Identified?*

________ *Yes*

___✓___ *No* (If NO, skip to the conclusion section below and check NO to indicate the pathway is *incomplete.)*

☐ *Q2: Currently inhabited buildings near subsurface contamination?*

________ *Yes*

___✓___ *No*

Areas of future concern near subsurface contamination?

________ *Yes*

___✓___ *No* (If NO, skip to the conclusion section below and check NO to indicate the pathway is *incomplete.)*

☐ *Q3: Immediate Actions Warranted?*

________ *Yes*

___✓___ *No*

Secondary Screening Summary

☐ *Vapor source identified:*

_____ *Groundwater*

_____ *Soil*

_____ *Insufficient data*

☐ *Indoor air data available?*

_____ *Yes*

_____ *No*

☐ *Indoor air concentrations exceed target levels?*

_____ *Yes*

_____ *No*

☐ *Subsurface data evaluation: (Circle appropriate answers below)*

Medium	**Q4 Levels Exceeded?**	**Q5 Levels Exceeded?**	**Data Indicates Pathway is Complete?**
Groundwater	YES / NO / NA / INS	YES / NO / NA / INS	YES / NO / INS
Soil Gas	YES / NO / NA / INS	YES / NO / NA / INS	YES / NO / INS

NA = not applicable
INS = insufficient data available to make a determination

Site-Specific Summary

☐ *Have the nature and extent of subsurface contamination, potential preferential pathways and overlying building characteristics been adequately characterized to identify the most-likely-to-be-impacted buildings?*

_____ *Yes*

_____ *No*

_____ *N/A*

EPA recommends that if a model was used, it be an appropriate and applicable model that represents the conceptual site model. If other means were used, document how you determined the potentially most impacted areas to sample. EPA recommends that predictive modeling can be used to support Current Human Exposures Under Control EI determinations without confirmatory sampling to support this determination. Current Human Exposures Under Control EI determinations are intended to reflect a reasonable conclusion by EPA or the State that current human exposures are under control with regard to the vapor intrusion pathway and current land use conditions. Therefore, if conducting evaluation for an EI determination, document that the **Pathway is Incomplete** and/or does not pose an unacceptable risk to human health for EI determinations.

☐ *Are you making an EI determination based on modeling and does the model prediction indicate that determination is expected to be adequately protective to support Current Human Exposures Under Control EI determinations?*

_____ *Yes*

_____ *No*

_____ *N/A*

☐ *Do subslab vapor concentrations exceed target levels?*

_____ *Yes*

_____ *No*

_____ *N/A*

☐ *Do indoor air concentrations exceed target levels?*

_____ *Yes*

_____ *No*

Conclusion

Is there a Complete Pathway for subsurface vapor intrusion to indoor air?

Below, check the appropriate conclusion for the Subsurface Vapor to Indoor Air Pathway evaluation and attach supporting documentation as well as a map of the facility.

_✓_ NO - the "Subsurface Vapor Intrusion to Indoor Air Pathway" has been verified to be incomplete for the __proposed ISB__ facility, EPA ID # _________, located at __BNL__.
This determination is based on a review of site information, as suggested in this guidance; check as appropriate:

_✓_ for current and reasonably expected conditions, or

_____ based on performance monitoring evaluations for engineered exposure controls. This determination may be re-evaluated, where appropriate, when the Agency/State becomes aware of any significant changes at the facility.

_____ YES –The "Subsurface Vapor to Indoor Air Pathway" is Complete. Engineered controls, avoidance actions, or removal actions taken include: ____________

_____ UNKNOWN - More information is needed to make a determination.

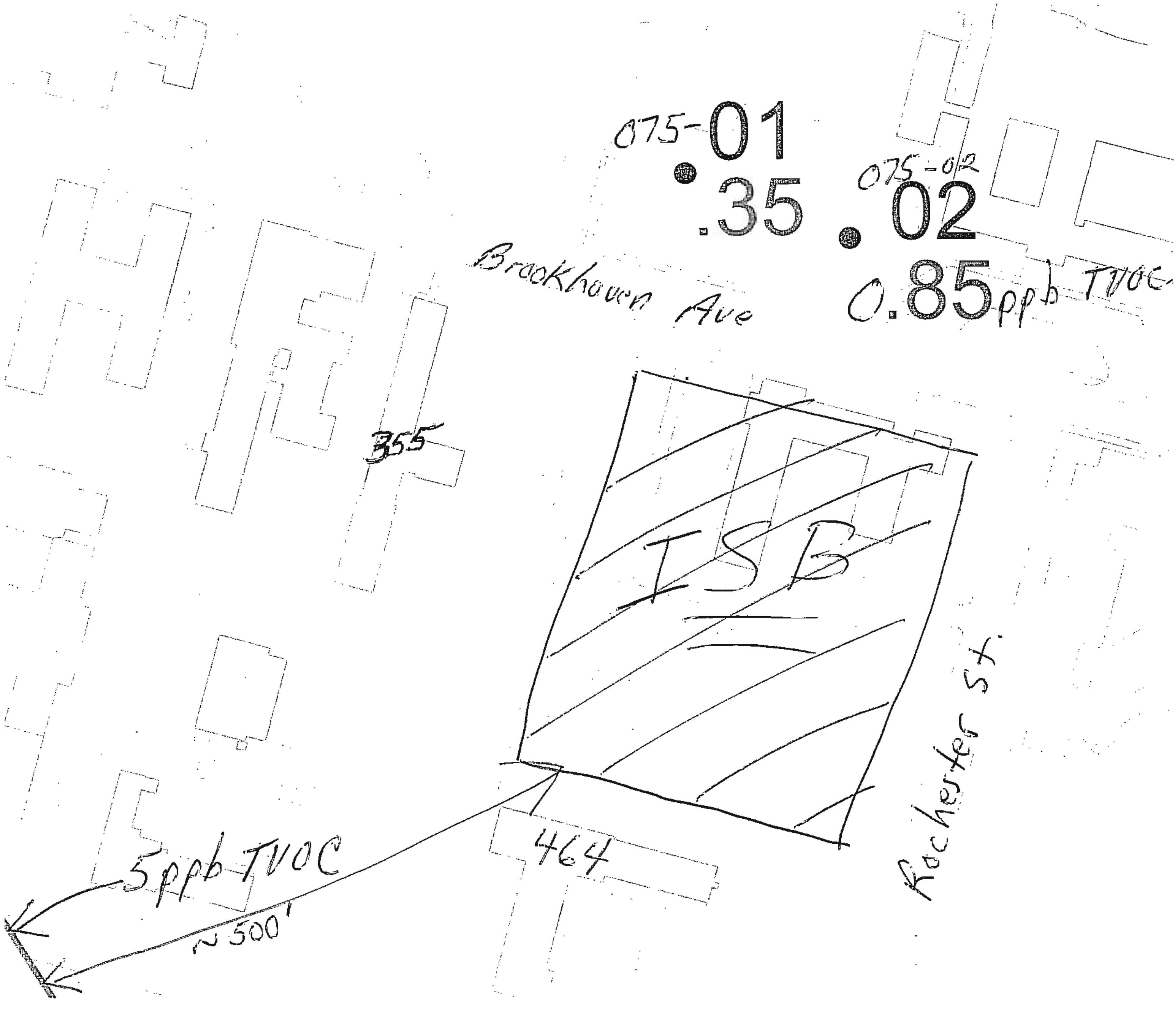
Locations where References may be found:

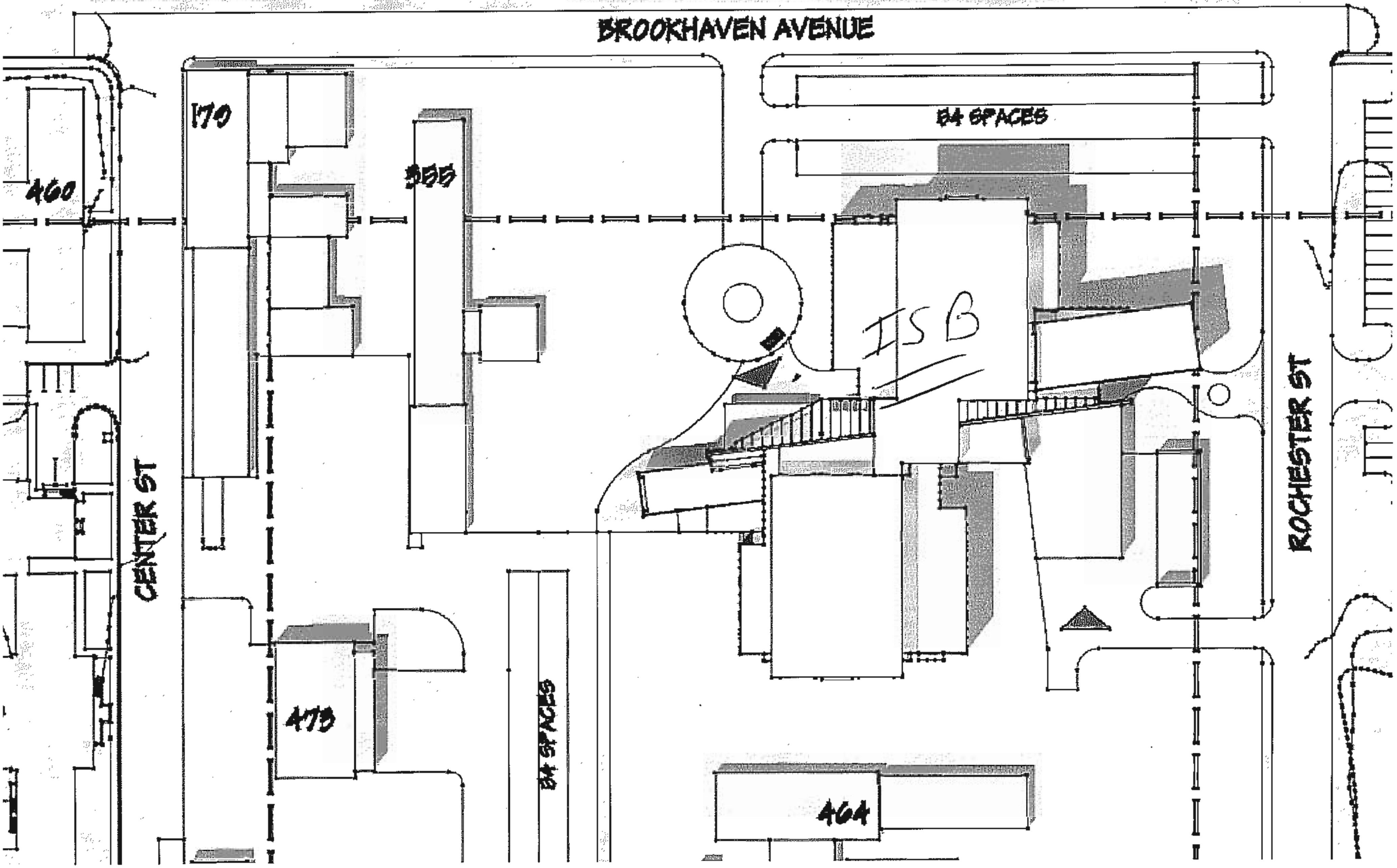
Contact telephone and e-mail numbers:

(name) Robert Howe 6/4/08

(phone #) ______________________

(e-mail) ______________________


075-01
.35
075-02
.02
0.85ppb TVOC
Brookhaven Ave
355
ISB
464
Rochester St.
5ppb TVOC
~500'


BROOKHAVEN AVENUE
84 SPACES
170
460
555
ISB
ROCHESTER ST
CENTER ST
473
84 SPACES
464

Monitoring Wells Near ISB (6/4/08)

Site ID: 075-01

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
524.2 TVOC	1/28/2002	0	--	--	UG/L	45	
524.2 TVOC	4/30/2002	0	--	--	UG/L	45	
524.2 TVOC	7/29/2002	0.28	--	--	UG/L	45	
Chloroform	7/29/2002	0.28	0.5	--	UG/L	45	J
524.2 TVOC	11/26/2002	0	--	--	UG/L	45	
524.2 TVOC	2/19/2003	0	--	--	UG/L	45	
524.2 TVOC	6/11/2003	0	--	--	UG/L	45	
524.2 TVOC	9/10/2003	0	--	--	UG/L	45	
524.2 TVOC	12/12/2003	0	--	--	UG/L	45	
524.2 TVOC	11/8/2004	0.17	--	--	UG/L	45	
Chloroform	11/8/2004	0.17	0.5	--	UG/L	45	J
524.2 TVOC	11/7/2005	0.21	--	--	UG/L	45	
Chloroform	11/7/2005	0.21	0.5	--	UG/L	45	J
524.2 TVOC	12/6/2006	0.4	--	--	UG/L	45	
Chloroform	12/6/2006	0.28	0.5	--	UG/L	45	J
Trichloroethylene	12/6/2006	0.12	0.5	--	UG/L	45	J
524.2 TVOC	11/15/2007	0.35	--	--	UG/L	45	
Chloroform	11/15/2007	0.35	0.5	--	UG/L	45	J

Site ID: 075-02

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
524.2 TVOC	1/28/2002	0	--	--	UG/L	50	
524.2 TVOC	4/30/2002	0	--	--	UG/L	50	
524.2 TVOC	7/29/2002	0	--	--	UG/L	50	
524.2 TVOC	11/26/2002	0	--	--	UG/L	50	
524.2 TVOC	2/19/2003	0	--	--	UG/L	50	
524.2 TVOC	6/11/2003	0	--	--	UG/L	50	
524.2 TVOC	9/10/2003	0	--	--	UG/L	50	
524.2 TVOC	12/12/2003	0	--	--	UG/L	50	
524.2 TVOC	11/8/2004	0.1	--	--	UG/L	50	
Chloroform	11/8/2004	0.1	0.5	--	UG/L	50	J
524.2 TVOC	11/7/2005	0	--	--	UG/L	50	
1,1,1-Trichloroethane	12/6/2006	0.092	0.5	--	UG/L	50	J
524.2 TVOC	12/6/2006	3.192	--	--	UG/L	50	
Chloroform	12/6/2006	3.1	0.5	--	UG/L	50	
524.2 TVOC	11/15/2007	0.85	--	--	UG/L	50	
Chloroform	11/15/2007	0.85	0.5	--	UG/L	50	

Environmental & Waste Management Services Division

BROOKHAVEN
NATIONAL LABORATORY

Building 51
P.O. Box 5000
Upton, NY 11973-5000
Phone 631 344-5588
Fax 631 344-7776
howe@bnl.gov

managed by Brookhaven Science Associates
for the U.S. Department of Energy

Memo

date: *September 12, 2006*

to: *File*

from: *R. Howe* RHowe

subject: SOIL GAS VAPOR EVALUATION FOR NEW BUILDINGS

Two buildings, for Research Support and the Center for Functional Nanomaterials, are currently being constructed at BNL. This memo documents the potential for soil gas vapor buildup in these buildings, as well as the National Synchrotron Light Source II, that is currently in the planning stage.

As identified in the attached preliminary initial screening for these three buildings, a clean layer of groundwater exists above any volatile contaminants within the areas of the three buildings. Therefore, the subsurface to indoor air pathway is incomplete, and no further evaluation is needed at this time.

Attachment

Copy: M. Davis
W. Dorsch
G. Penny
File: GWER 59.06
N. Gmur (w/attach) NSLS

9/12/06

FOR CFN, Research Support, and NSLS II

IV. TIER 1 - Primary Screening

Primary Screening is designed to help quickly screen out sites at which the vapor intrusion pathway does not ordinarily need further consideration, and point out the sites that do typically need further consideration. This evaluation involves determining whether any potential exists at a specific site for vapor intrusion to result in unacceptable indoor inhalation risks and, if so, whether immediate action may be warranted. Recommended criteria for making these determinations are presented in Questions 1 through 3, which focus on identifying:

a) if chemicals of sufficient volatility and toxicity are present or reasonably suspected to be present (Question 1);
b) if inhabited buildings are located (or will be constructed under future development scenarios – except for Environmental Indicator determinations, see section IV.C below) above or in close proximity to subsurface contamination (Question 2); and
c) if current conditions warrant immediate action (Question 3).

This primary screening process is illustrated in a flow diagram included in Appendix C.

A. Primary Screening – Question #1

Q1: Are chemicals of sufficient volatility and toxicity known or reasonably suspected to be present in the subsurface (e.g., in unsaturated soils, soil gas, or the uppermost portions of the ground water and/or capillary fringe – see **Table 1)?** (We recommend this consideration involve DQOs (see Appendix A) used in acquiring the site data as well as an appropriately scaled Conceptual Site Model (CSM) for vapor intrusion (see Appendix B).)

_____ If **YES** - check here, check off the relevant chemicals on Table 1, and continue with Question 2. The chemicals identified here (and any degradation products) are evaluated as constituents of potential concern in subsequent questions.

__✓__ If **NO** - check here, provide the rationale and references below, and then go to the Summary Page to document that the subsurface vapor to indoor air pathway is incomplete (i.e., no further consideration of this pathway is needed); or

_____ If sufficient data are not available, go to the Summary Page and document the need for more information. After collecting the necessary data, Question 1 can then be revisited with the newly collected data to re-evaluate the completeness of the vapor intrusion pathway.

1. What is the goal of this question?

This question is designed to help quickly screen out sites at which the vapor intrusion pathway generally does not need further consideration. This evaluation involves determining whether or not any potential exists at a specific site for the vapor intrusion

B. Primary Screening – Question #2

Q2: Are currently (or potentially) inhabited buildings or areas of concern under future development scenarios located *near* (see discussion below) subsurface contaminants found in Table 1?

_____ If **YES** – check here, identify buildings and/or areas of concern below, and document on the Summary Page whether the potential for impacts from the vapor intrusion pathway applies to currently inhabited buildings or areas of concern under reasonably anticipated future development scenarios, or both. (Note that for EI considerations, we recommend only current risks be evaluated.) Then proceed with Question 3.

__✓__ If **NO** – check here, describe the rationale below, and then go to the Summary Page to document that there is no potential for the vapor intrusion pathway to impact either currently inhabited buildings or areas of concern under future development scenarios (i.e., no further evaluation of this pathway is needed). (Note that for EI considerations, only current risks are evaluated.); or

_____ If sufficient data are not available – check here and document the need for more information on the Summary Page. After collecting the necessary data, Question 2 can then be revisited with the newly collected data to re-evaluate the completeness of the vapor intrusion pathway.

1. What is the goal of this question?

The goal of this question is to help determine whether inhabited buildings currently are located (or may be reasonably expected to be located under future development scenarios) above or in close proximity to subsurface contamination that potentially could result in unacceptable indoor air inhalation risks. If inhabited buildings and/or future development are not located "near" the area of concern, we suggest that the vapor intrusion pathway be considered incomplete and no further consideration of the pathway should be needed.

For the purposes of this question, **"inhabited buildings"** are structures with enclosed air space that are designed for human occupancy. Table 1, discussed above in Question 1, lists the **"subsurface contaminants demonstrating sufficient volatility and toxicity"** to potentially pose an inhalation risk. We recommend that an inhabited building generally be considered **"near"** subsurface contaminants if it is located within approximately 100 ft laterally or vertically of known or interpolated soil gas or groundwater contaminants listed in Table 1 (or others not included in table 1 – see Question 1) and the contamination occurs in the unsaturated zone and/or the uppermost saturated zone. If the source of contamination is groundwater, we recommend migration of the contaminant plume be considered when evaluating the potential for future risks. The distance suggested above (100 feet) may not be appropriate for all sites (or contaminants) and,

significant advective transport of the vapors downward through cracks/openings in floors and into the vadose zone. In these cases, diffusive transport of vapors is usually overridden by advective transport, and the vapors may be transported in the vadose zone several hundred feet from the source of contamination.

Finally, this guidance is intended to be applied to existing groundwater plumes as they are currently defined (e.g., MCLs, State Standards, or Risk-Based Concentrations). However, it is very important to recognize that some non-potable aquifers may have plumes that have been defined by threshold concentrations significantly higher than drinking-water concentrations. In these cases, contamination that is not technically considered part of the plume may still pose significant risks via the vapor intrusion pathway and, consequently, the plume definition may need to be expanded. Similarly, we recommend evaluating the technologies used to obtain soil gas and indoor air concentrations to determine if appropriate methods were used to ensure adequate data quality at the time analyses were conducted.

4. Identify Inhabited Buildings (or Areas With Potential for Future Residential Development) Within Distances of Possible Concern:

- NSIS II - future potential building - outside of any contaminant plume.
- Research Support - in construction - Primarily outside plume. No pathway since clean gw exists ~~abo~~ below bldg
- CFN - in construction - Sits above very low level contamination in plume, but clean gw exists beneath the building, therefore no pathway.

Overall the subsurface vapor to indoor air pathway is incomplete and no further evaluation is needed at this time.

building and b) measured or likely vapor concentrations that may be flammable/combustible, corrosive, or chemically reactive.

3. ***Rationale and Reference(s):***

None

☐ *Subsurface data evaluation: (Circle appropriate answers below)*

Medium	**Q4 Levels Exceeded?**	**Q5 Levels Exceeded?**	**Data Indicates Pathway is Complete?**
Groundwater	YES / NO / NA / INS	YES / NO / NA / INS	YES / NO / INS
Soil Gas	YES / NO / NA / INS	YES / NO / NA / INS	YES / NO / INS

NA = not applicable
INS = insufficient data available to make a determination

Site-Specific Summary

☐ *Have the nature and extent of subsurface contamination, potential preferential pathways and overlying building characteristics been adequately characterized to identify the most-likely-to-be-impacted buildings?*

_____ *Yes*

_____ *No*

_____ *N/A*

EPA recommends that if a model was used, it be an appropriate and applicable model that represents the conceptual site model. If other means were used, document how you determined the potentially most impacted areas to sample. EPA recommends that predictive modeling can be used to support Current Human Exposures Under Control EI determinations without confirmatory sampling to support this determination. Current Human Exposures Under Control EI determinations are intended to reflect a reasonable conclusion by EPA or the State that current human exposures are under control with regard to the vapor intrusion pathway and current land use conditions. Therefore, if conducting evaluation for an EI determination, document that the **Pathway is Incomplete** and/or does not pose an unacceptable risk to human health for EI determinations.

☐ *Are you making an EI determination based on modeling and does the model prediction indicate that determination is expected to be adequately protective to support Current Human Exposures Under Control EI determinations?*

_____ *Yes*

_____ *No*

_____ *N/A*

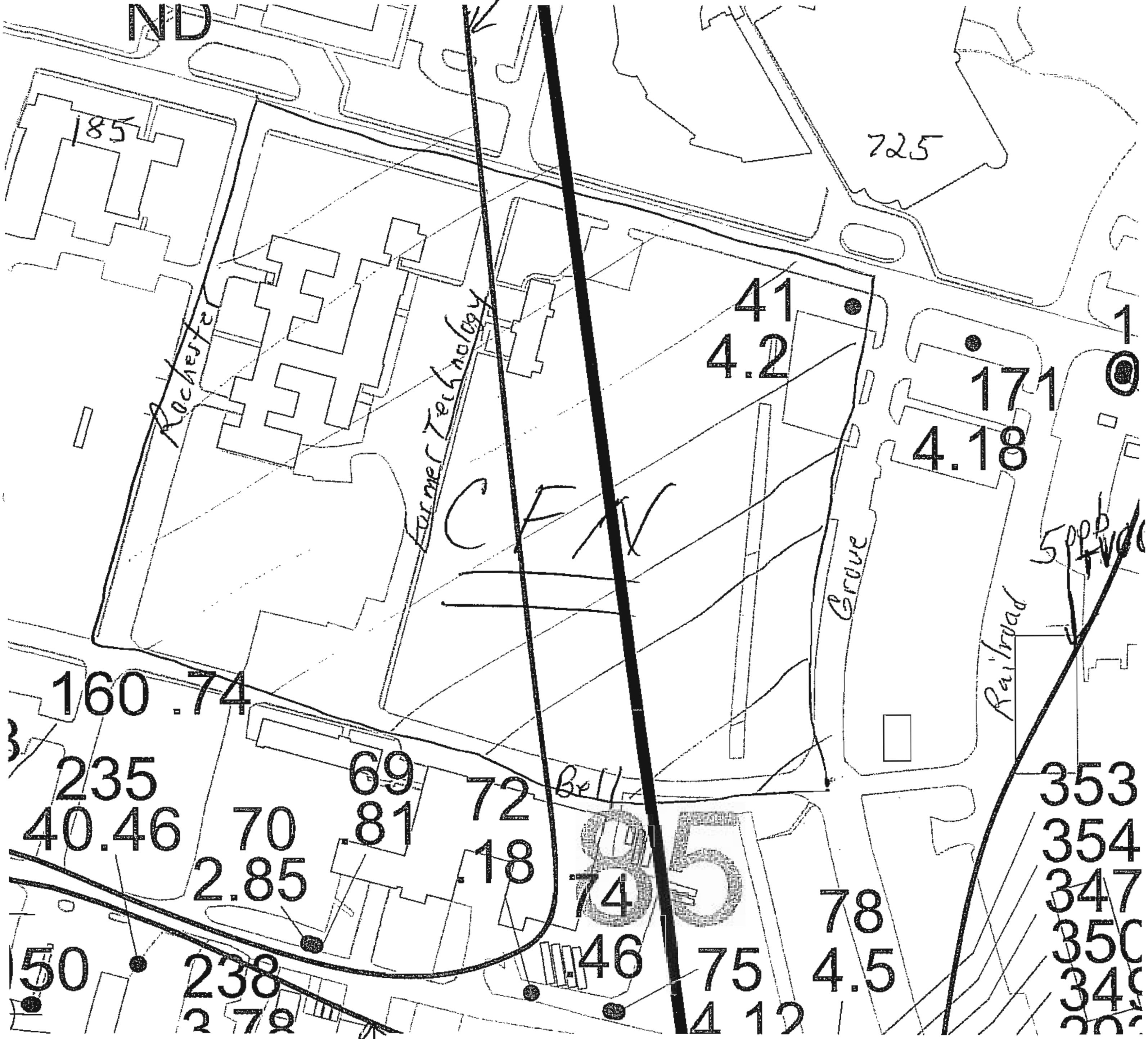
☐ *Do subslab vapor concentrations exceed target levels?*

_____ *Yes*

_____ *No*

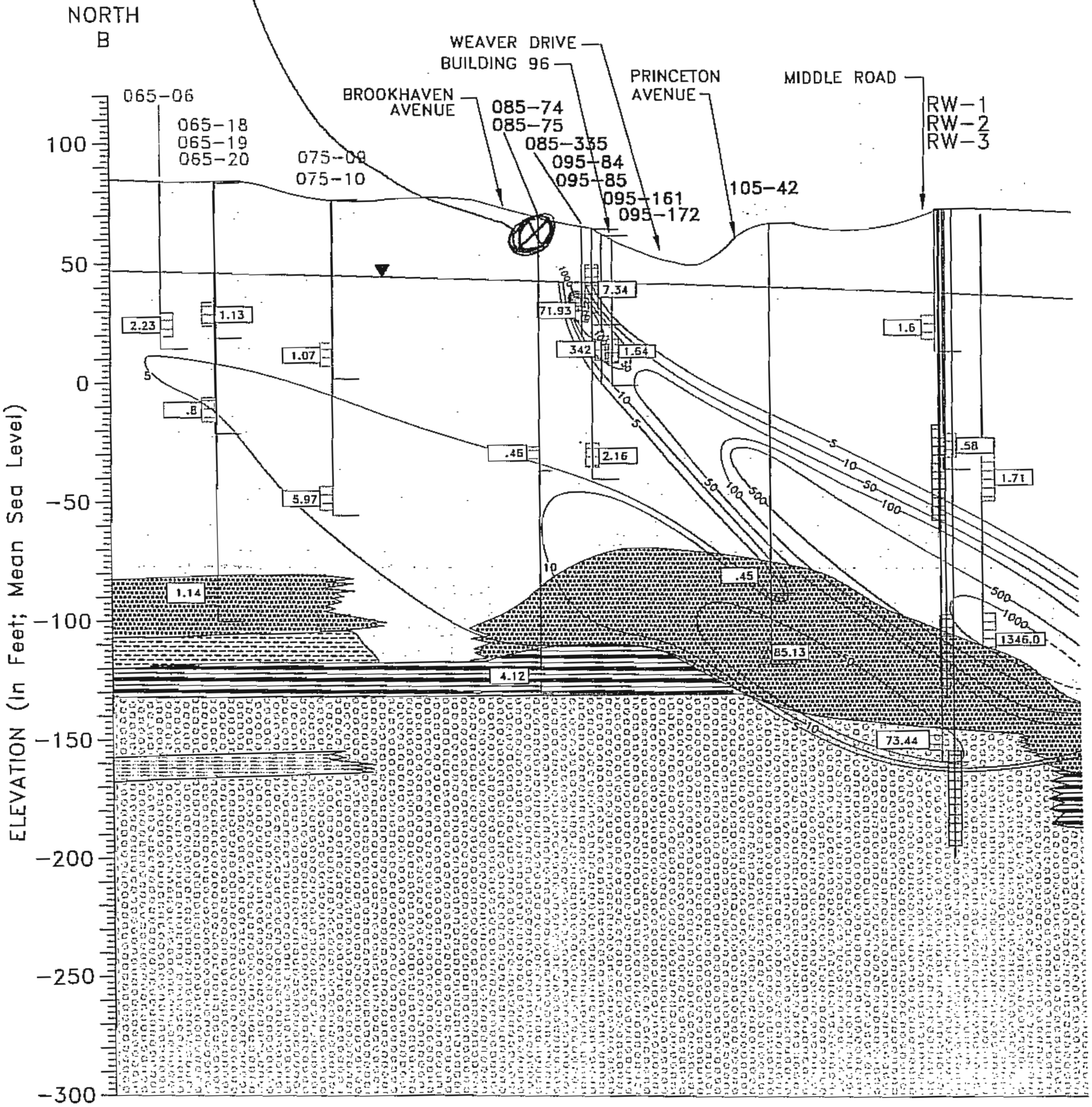
_____ *N/A*

5ppb TVOC



10 ppb TVOC

CFN



\\OERNT\GIS\GW_PROJECTS\CY_2005_GW_REPORT\FINAL_DRAFT_FIGURES\FIG_3.02-02.DWG

LEGEND

Upper Glacial aquifer

- ☐ UG Upper Glacial Sands
- ▨ UC Upper Glacial Silts & Clays
- ▨ UU Upton Unit

Gardiners Clay

- ▤ GL Gardiners Clay
- ▤ GS Gardiners Clay – Silt

Magothy aquifer

- ▨ MA Magothy Sands and Clay
- ▤ MB Magothy Brown Clay
- ▤ MC Magothy Clays (undiff)
- ▦ MO Magothy – OTHER

000-114 BNL W

1.13 TVOC

ND Not d
labora

NS Not S

—50— TVOC
(Dashe

HORIZONTAL SCALE
0 500 1000 FEET

BROOKHAVEN
NATIONAL LABORATORY

EWMS DIVISION

TITLE:

TVOC HYDROGEOLOG

2005 BNL GRC

CFN Monitor Wells

9/12/2006

Site ID: 075-01

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
524.2 TVOC	2/25/2000	0.95	--	--	UG/L	45	
Chloroform	2/25/2000	0.95	0.5	--	UG/L	45	
524.2 TVOC	6/16/2000	1.9	--	--	UG/L	45	
Chloroform	6/16/2000	0.7	0.5	--	UG/L	45	
Methylene chloride	6/16/2000	1.2	0.5	--	UG/L	45	
Gross Beta	8/1/2000	5.05	2.28	3.04	PCI/L	50	
Potassium-40	8/1/2000	30.9	0	27.90888	PCI/L	50	
Tritium	8/1/2000	585	320	460	PCI/L	50	
524.2 TVOC	9/11/2000	1.85	--	--	UG/L	45	
Chloroform	9/11/2000	1	0.5	--	UG/L	45	
Methylene chloride	9/11/2000	0.85	0.5	--	UG/L	45	
524.2 TVOC	11/30/2000	1	--	--	UG/L	45	
Chloroform	11/30/2000	1	0.5	--	UG/L	45	
524.2 TVOC	2/20/2001	0.32	--	--	UG/L	45	
Chloroform	2/20/2001	0.32	0.5	--	UG/L	45	J
524.2 TVOC	5/15/2001	0.37	--	--	UG/L	45	
Chloroform	5/15/2001	0.37	0.5	--	UG/L	45	J
1,1-Dichloroethylene	8/9/2001	0.93	0.5	--	UG/L	50	
524.2 TVOC	8/9/2001	2.19	--	--	UG/L	50	
Gross Beta	8/9/2001	1.26	0.908	0.509	PCI/L	50	J-N2
Toluene	8/9/2001	0.66	0.5	--	UG/L	50	
Trichloroethylene	8/9/2001	0.6	0.5	--	UG/L	50	
Tritium	8/9/2001	436	329	209	PCI/L	50	J-N2
524.2 TVOC	10/26/2001	0.37	--	--	UG/L	45	
Toluene	10/26/2001	0.37	0.5	--	UG/L	45	J
524.2 TVOC	1/28/2002	0	--	--	UG/L	45	
524.2 TVOC	4/30/2002	0	--	--	UG/L	45	
524.2 TVOC	7/29/2002	0.28	--	--	UG/L	45	
Chloroform	7/29/2002	0.28	0.5	--	UG/L	45	J
524.2 TVOC	11/26/2002	0	--	--	UG/L	45	
524.2 TVOC	2/19/2003	0	--	--	UG/L	45	
524.2 TVOC	6/11/2003	0	--	--	UG/L	45	
524.2 TVOC	9/10/2003	0	--	--	UG/L	45	
524.2 TVOC	12/12/2003	0	--	--	UG/L	45	
524.2 TVOC	11/8/2004	0.17	--	--	UG/L	45	
Chloroform	11/8/2004	0.17	0.5	--	UG/L	45	J
524.2 TVOC	11/7/2005	0.21	--	--	UG/L	45	
Chloroform	11/7/2005	0.21	0.5	--	UG/L	45	J

Site ID: 075-02

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
524.2 TVOC	2/25/2000	0	--	--	UG/L	50	
524.2 TVOC	6/16/2000	1.1	--	--	UG/L	50	
Cesium-137	6/16/2000	2.46	2.33	2.17	PCI/L	50	J
Gross Beta	6/16/2000	2.24	1.38	0.806	PCI/L	50	J
Methylene chloride	6/16/2000	1.1	0.5	--	UG/L	50	
Gross Beta	8/1/2000	2.61	2.28	2.88	PCI/L	50	
Thallium-208	8/1/2000	3.61	0	1.421618	PCI/L	50	

Tritium	8/1/2000	881	320	490	PCI/L	50	
524.2 TVOC	9/11/2000	0.67	--	--	UG/L	50	
Methylene chloride	9/11/2000	0.67	0.5	--	UG/L	50	
524.2 TVOC	11/30/2000	0	--	--	UG/L	50	
524.2 TVOC	2/20/2001	0	--	--	UG/L	50	
524.2 TVOC	5/15/2001	0	--	--	UG/L	50	
1,1-Dichloroethylene	8/9/2001	3.6	0.5	--	UG/L	50	
524.2 TVOC	8/9/2001	5.84	--	--	UG/L	50	
Chloroform	8/9/2001	0.26	0.5	--	UG/L	50	J
Toluene	8/9/2001	0.81	0.5	--	UG/L	50	
Trichloroethylene	8/9/2001	0.64	0.5	--	UG/L	50	
Trichlorofluoromethane	8/9/2001	0.53	0.5	--	UG/L	50	
524.2 TVOC	10/26/2001	0.32	--	--	UG/L	50	
Chloroform	10/26/2001	0.32	0.5	--	UG/L	50	J
524.2 TVOC	1/28/2002	0	--	--	UG/L	50	
524.2 TVOC	4/30/2002	0	--	--	UG/L	50	
524.2 TVOC	7/29/2002	0	--	--	UG/L	50	
524.2 TVOC	11/26/2002	0	--	--	UG/L	50	
524.2 TVOC	2/19/2003	0	--	--	UG/L	50	
524.2 TVOC	6/11/2003	0	--	--	UG/L	50	
524.2 TVOC	9/10/2003	0	--	--	UG/L	50	
524.2 TVOC	12/12/2003	0	--	--	UG/L	50	
524.2 TVOC	11/8/2004	0.1	--	--	UG/L	50	
Chloroform	11/8/2004	0.1	0.5	--	UG/L	50	J
524.2 TVOC	11/7/2005	0	--	--	UG/L	50	

Site ID: 075-210

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
524.2 TVOC	1/24/2000	0.429	--	--	UG/L	58	
Benzene	1/24/2000	0.1	0.5	--	UG/L	58	J
Benzene, 1,2,4-trimethyl	1/24/2000	0.028	0.5	--	UG/L	58	J
Chloroform	1/24/2000	0.14	0.5	--	UG/L	58	J
Ethylbenzene	1/24/2000	0.034	0.5	--	UG/L	58	J
m/p xylene	1/24/2000	0.061	0.5	--	UG/L	58	J
o-Xylene	1/24/2000	0.022	0.5	--	UG/L	58	J
1,1,1-Trichloroethane	7/20/2000	5.1	0.5	--	UG/L	58	
1,1-Dichloroethane	7/20/2000	0.67	0.5	--	UG/L	58	
1,1-Dichloroethylene	7/20/2000	1.6	0.5	--	UG/L	58	
524.2 TVOC	7/20/2000	8.33	--	--	UG/L	58	
Chloroform	7/20/2000	0.96	0.5	--	UG/L	58	
1,1,1-Trichloroethane	2/7/2001	4.2	0.5	--	UG/L	59	
1,1-Dichloroethane	2/7/2001	0.88	0.5	--	UG/L	59	
1,1-Dichloroethylene	2/7/2001	1.5	0.5	--	UG/L	59	
524.2 TVOC	2/7/2001	7.2	--	--	UG/L	59	
Chloroform	2/7/2001	0.62	0.5	--	UG/L	59	
1,1,1-Trichloroethane	7/12/2001	5.2	0.5	--	UG/L	58	
1,1-Dichloroethane	7/12/2001	1.1	0.5	--	UG/L	58	
1,1-Dichloroethylene	7/12/2001	1.6	0.5	--	UG/L	58	
524.2 TVOC	7/12/2001	8.96	--	--	UG/L	58	
Chloroform	7/12/2001	0.64	0.5	--	UG/L	58	
Methylene chloride	7/12/2001	0.42	0.5	--	UG/L	58	J
Tritium	7/12/2001	1060	409	283	PCI/L	58	

1,1,1-Trichloroethane	10/17/2001	7.9	0.5	--	UG/L	59	
1,1-Dichloroethane	10/17/2001	2.1	0.5	--	UG/L	59	
1,1-Dichloroethylene	10/17/2001	2.9	0.5	--	UG/L	59	
524.2 TVOC	10/17/2001	13.58	--	--	UG/L	59	
Chloroform	10/17/2001	0.68	0.5	--	UG/L	59	
Tritium	10/17/2001	1010	427	291	PCI/L	59	
Tritium	7/22/2002	488	373	236	PCI/L	59	J
1,1,1-Trichloroethane	10/16/2002	2.4	0.5	--	UG/L	59	
1,1-Dichloroethane	10/16/2002	0.75	0.5	--	UG/L	59	
1,1-Dichloroethylene	10/16/2002	0.69	0.5	--	UG/L	59	
524.2 TVOC	10/16/2002	4.63	--	--	UG/L	59	
Chloroform	10/16/2002	0.79	0.5	--	UG/L	59	
Tritium	10/16/2002	660	509	321	PCI/L	59	J
524.2 TVOC	10/30/2003	6	--	--	UG/L	59	
Chloroform	10/30/2003	6	0.5	--	UG/L	59	J
1,1,1-Trichloroethane	10/20/2004	0.27	0.5	--	UG/L	58	J
524.2 TVOC	10/20/2004	3.24	--	--	UG/L	58	
Chloroform	10/20/2004	2.8	0.5	--	UG/L	58	
Tetrachloroethylene	10/20/2004	0.17	0.5	--	UG/L	58	J
524.2 TVOC	10/20/2005	0	--	--	UG/L	58	
Tritium	4/21/2006	330	320	210	PCI/L	59	J

Site ID: 085-171

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
1,1,1-Trichloroethane	1/24/2000	21.8	0.5	--	UG/L	135	
1,1-Dichloroethane	1/24/2000	1	0.5	--	UG/L	135	
1,1-Dichloroethylene	1/24/2000	9.7	0.5	--	UG/L	135	
1,2-Dichloroethane	1/24/2000	0.11	0.5	--	UG/L	135	J
524.2 TVOC	1/24/2000	35.892	--	--	UG/L	135	
Chloroform	1/24/2000	0.36	0.5	--	UG/L	135	J
m/p xylene	1/24/2000	0.032	0.5	--	UG/L	135	J
Methylene chloride	1/24/2000	0.49	0.5	--	UG/L	135	JB
Toluene	1/24/2000	0.08	0.5	--	UG/L	135	JB
Trichloroethylene	1/24/2000	0.22	0.5	--	UG/L	135	J
Trichlorofluoromethane	1/24/2000	2.1	0.5	--	UG/L	135	
1,1,1-Trichloroethane	7/12/2000	19.8	0.5	--	UG/L	130	
1,1-Dichloroethane	7/12/2000	1.6	0.5	--	UG/L	130	
1,1-Dichloroethylene	7/12/2000	7.6	0.5	--	UG/L	130	
524.2 TVOC	7/12/2000	33.99	--	--	UG/L	130	
Chloroform	7/12/2000	0.84	0.5	--	UG/L	130	
Methylene chloride	7/12/2000	0.81	0.5	--	UG/L	130	B
Toluene	7/12/2000	0.38	0.5	--	UG/L	130	J
Trichloroethylene	7/12/2000	0.76	0.5	--	UG/L	130	
Trichlorofluoromethane	7/12/2000	2.2	0.5	--	UG/L	130	
Tritium	7/12/2000	714	412	267	PCI/L	130	J
Tritium	10/19/2000	1230	470	320	PCI/L	130	
1,1,1-Trichloroethane	2/13/2001	6	0.5	--	UG/L	130	
1,1-Dichloroethane	2/13/2001	0.41	0.5	--	UG/L	130	J
1,1-Dichloroethylene	2/13/2001	1.9	0.5	--	UG/L	130	
524.2 TVOC	2/13/2001	9.43	--	--	UG/L	130	
Chloroform	2/13/2001	0.82	0.5	--	UG/L	130	
Trichloroethylene	2/13/2001	0.3	0.5	--	UG/L	130	J

Tritium	2/13/2001	845	320	213	PCI/L	130	J
1,1,1-Trichloroethane	7/19/2001	10.5	0.5	--	UG/L	130	
1,1-Dichloroethane	7/19/2001	0.93	0.5	--	UG/L	130	
1,1-Dichloroethylene	7/19/2001	4.3	0.5	--	UG/L	130	
524.2 TVOC	7/19/2001	17.09	--	--	UG/L	130	
Chloroform	7/19/2001	1	0.5	--	UG/L	130	
Trichloroethylene	7/19/2001	0.36	0.5	--	UG/L	130	J
Tritium	7/19/2001	469	430	268	PCI/L	130	J-N2
1,1,1-Trichloroethane	10/15/2001	13.9	0.5	--	UG/L	130	
1,1-Dichloroethane	10/15/2001	0.8	0.5	--	UG/L	130	
1,1-Dichloroethylene	10/15/2001	5.3	0.5	--	UG/L	130	
524.2 TVOC	10/15/2001	21.48	--	--	UG/L	130	
Chloroform	10/15/2001	0.88	0.5	--	UG/L	130	
Methyl chloride	10/15/2001	0.27	0.5	--	UG/L	130	J
Trichloroethylene	10/15/2001	0.33	0.5	--	UG/L	130	J
1,1,1-Trichloroethane	10/18/2002	16.4	0.5	--	UG/L	130	
1,1-Dichloroethane	10/18/2002	1	0.5	--	UG/L	130	
1,1-Dichloroethylene	10/18/2002	5.1	0.5	--	UG/L	130	
524.2 TVOC	10/18/2002	24.04	--	--	UG/L	130	
Chloroform	10/18/2002	0.96	0.5	--	UG/L	130	
Methylene chloride	10/18/2002	0.29	0.5	--	UG/L	130	J
Trichloroethylene	10/18/2002	0.29	0.5	--	UG/L	130	J
Tritium	8/6/2003	321	273	180	PCI/L	130	
1,1,1-Trichloroethane	10/30/2003	4.4	0.5	--	UG/L	130	J
1,1-Dichloroethane	10/30/2003	0.45	0.5	--	UG/L	130	J
1,1-Dichloroethylene	10/30/2003	1.6	0.5	--	UG/L	130	J
524.2 TVOC	10/30/2003	7.67	--	--	UG/L	130	
Chloroform	10/30/2003	0.77	0.5	--	UG/L	130	J
Methyl tert-butyl ether	10/30/2003	0.45	0.5	--	UG/L	130	J
Tritium	2/10/2004	350	220	180	PCI/L	130	J
1,1,1-Trichloroethane	4/11/2005	2.7	0.5	--	UG/L	130	
1,1-Dichloroethane	4/11/2005	0.53	0.5	--	UG/L	130	
1,1-Dichloroethylene	4/11/2005	1.3	0.5	--	UG/L	130	
524.2 TVOC	4/11/2005	6.01	--	--	UG/L	130	
Chloroform	4/11/2005	1.2	0.5	--	UG/L	130	
Toluene	4/11/2005	0.12	0.5	--	UG/L	130	J
Trichloroethylene	4/11/2005	0.16	0.5	--	UG/L	130	J
1,1,1-Trichloroethane	12/22/2005	2.1	0.5	--	UG/L	130	
1,1-Dichloroethane	12/22/2005	0.49	0.5	--	UG/L	130	J
1,1-Dichloroethylene	12/22/2005	1	0.5	--	UG/L	130	
524.2 TVOC	12/22/2005	4.18	--	--	UG/L	130	
Chloroform	12/22/2005	0.42	0.5	--	UG/L	130	J
Trichloroethylene	12/22/2005	0.17	0.5	--	UG/L	130	J
Tritium	12/22/2005	360	360	230	PCI/L	130	J
Tritium	1/24/2006	550	280	220	PCI/L	130	
Tritium	4/14/2006	460	350	230	PCI/L	130	J
Tritium	7/11/2006	550	390	270	PCI/L	130	

Site ID: 085-41

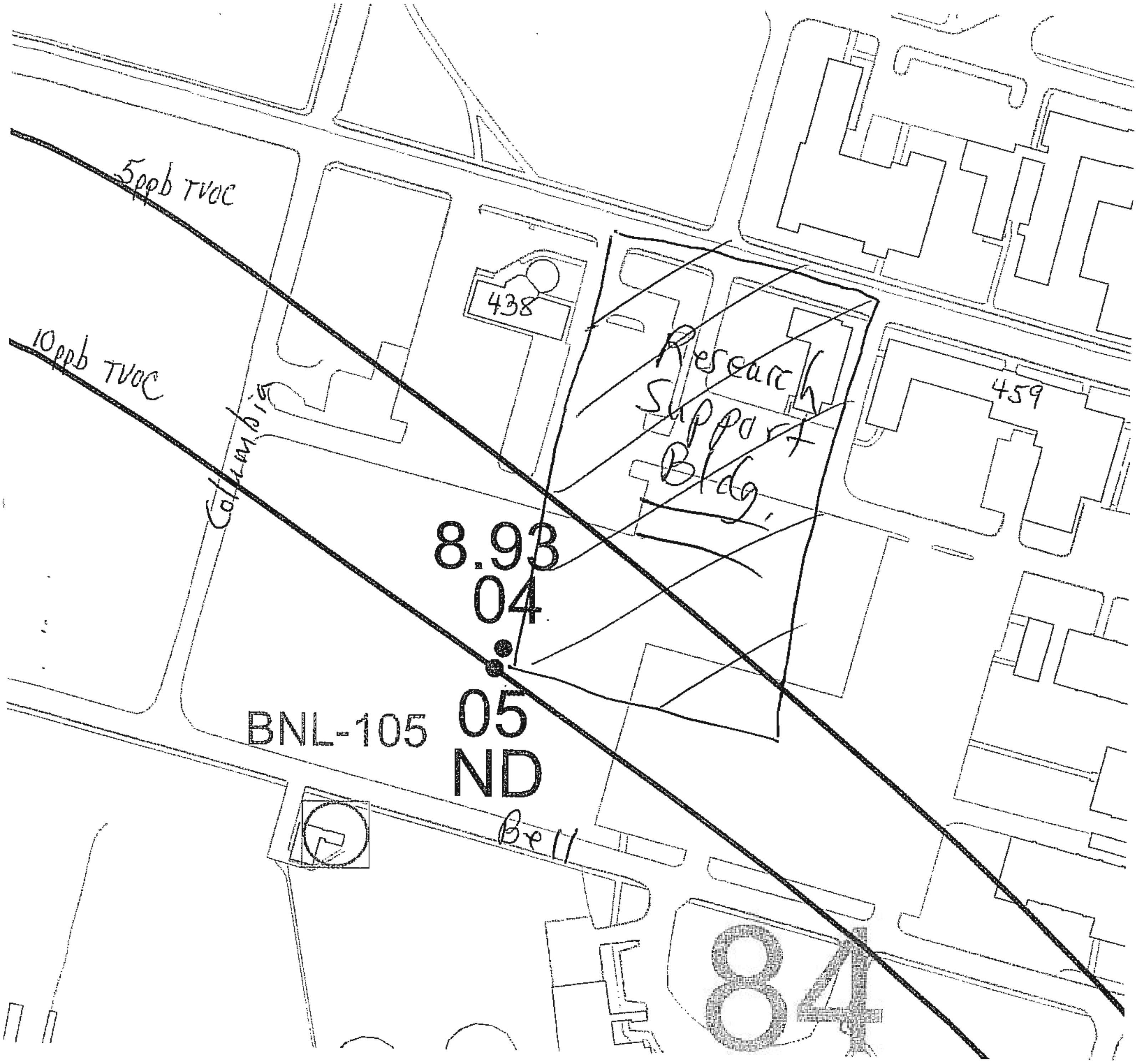
Table 2a

3000

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
1,1,1-Trichloroethane	1/10/2000	3.5	0.5	--	UG/L	189.5	
1,1-Dichloroethane	1/10/2000	0.5	0.5	--	UG/L	189.5	J

1,1-Dichloroethylene	1/10/2000	1.4	0.5	--	UG/L	189.5		- 190
1,2-Dichloroethane	1/10/2000	0.5	0.5	--	UG/L	189.5	J	- 230
524.2 TVOC	1/10/2000	12.2	--	--	UG/L	189.5		
Benzene	1/10/2000	0.5	0.5	--	UG/L	189.5	JB	
Benzene, 1,2,4-trimethyl	1/10/2000	0.5	0.5	--	UG/L	189.5	JB	
Benzene, 1,3,5-trimethyl-	1/10/2000	0.5	0.5	--	UG/L	189.5	J	
Benzene, 1-methylethyl-	1/10/2000	0.5	0.5	--	UG/L	189.5	J	
Chloroform	1/10/2000	0.65	0.5	--	UG/L	189.5		- 80
Cymene	1/10/2000	0.5	0.5	--	UG/L	189.5	J	
Ethylbenzene	1/10/2000	0.5	0.5	--	UG/L	189.5	J	
m/p xylene	1/10/2000	0.5	0.5	--	UG/L	189.5	J	
n-Propylbenzene	1/10/2000	0.5	0.5	--	UG/L	189.5	J	
Toluene	1/10/2000	0.65	0.5	--	UG/L	189.5	B	
Trichloroethylene	1/10/2000	0.5	0.5	--	UG/L	189.5	J	
Trichlorofluoromethane	1/10/2000	0.5	0.5	--	UG/L	189.5	JB	
1,1,1-Trichloroethane	8/7/2000	0.93	0.5	--	UG/L	189.5		
524.2 TVOC	8/7/2000	1.35	--	--	UG/L	189.5		
Chloroform	8/7/2000	0.42	0.5	--	UG/L	189.5	J	
Tritium	8/7/2000	701	486	311	PCI/L	189.5	J	
Tritium	10/17/2000	1970	453	337	PCI/L	189.5		
1,1,1-Trichloroethane	1/31/2001	3.1	0.5	--	UG/L	189.5		
1,1-Dichloroethane	1/31/2001	0.31	0.5	--	UG/L	189.5	J	
1,1-Dichloroethylene	1/31/2001	1.5	0.5	--	UG/L	189.5		
524.2 TVOC	1/31/2001	4.91	--	--	UG/L	189.5		
Tritium	1/31/2001	2460	429	346	PCI/L	189.5		
1,1,1-Trichloroethane	7/11/2001	0.48	0.5	--	UG/L	189.5	J	
524.2 TVOC	7/11/2001	0.75	--	--	UG/L	189.5		
Methyl chloride	7/11/2001	0.27	0.5	--	UG/L	189.5	J	
Tritium	7/11/2001	410	404	251	PCI/L	189.5	J-N2	
1,1,1-Trichloroethane	10/15/2001	0.31	0.5	--	UG/L	89.5	J	
524.2 TVOC	10/15/2001	0.96	--	--	UG/L	89.5		
Chloroform	10/15/2001	0.39	0.5	--	UG/L	89.5	J	
Toluene	10/15/2001	0.26	0.5	--	UG/L	89.5	J	
Tritium	1/16/2002	721	382	253	PCI/L	189.5	J	
Tritium	7/10/2002	621	514	323	PCI/L	189.5	J	
1,1,1-Trichloroethane	10/17/2002	0.37	0.5	--	UG/L	189.5	J	
524.2 TVOC	10/17/2002	4.27	--	--	UG/L	189.5		
Chloroform	10/17/2002	3.9	0.5	--	UG/L	189.5		
524.2 TVOC	10/27/2003	6.6	--	--	UG/L	189.5		
Chloroform	10/27/2003	6.6	0.5	--	UG/L	189.5		
1,1,1-Trichloroethane	10/13/2004	3.3	0.5	--	UG/L	189.5		
1,1-Dichloroethane	10/13/2004	0.64	0.5	--	UG/L	189.5		
1,1-Dichloroethylene	10/13/2004	1.2	0.5	--	UG/L	189.5		
1,2,3-Trichlorobenzene	10/13/2004	0.44	0.5	--	UG/L	189.5	J	
524.2 TVOC	10/13/2004	15.77	--	--	UG/L	189.5		
Chloroform	10/13/2004	1.7	0.5	--	UG/L	189.5		
Tetrachloroethylene	10/13/2004	8	0.5	--	UG/L	189.5		
Trichloroethylene	10/13/2004	0.49	0.5	--	UG/L	189.5	J	
Tritium	10/13/2004	500	230	200	PCI/L	189.5	J	
Tritium	4/1/2005	410	180	170	PCI/L	187.5	J	
1,1,1-Trichloroethane	10/21/2005	0.15	0.5	--	UG/L	189.5	J	
1,1-Dichloroethane	10/21/2005	0.15	0.5	--	UG/L	189.5	J	

524.2 TVOC	10/21/2005	4.2	--	--	UG/L	189.5	
Chloroform	10/21/2005	3.9	0.5	--	UG/L	189.5	


5ppb TVOC
10ppb TVOC
438
Research Support Bldg.
459
Columbia
8.93
04
BNL-105
05
ND
Bell
84

Research Support Bldg. Monitor Wells

9/12/2006

Site ID: 084-04

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
1,1,1-Trichloroethane	2/28/2000	9.1	0.5	--	UG/L	150	
1,1-Dichloroethane	2/28/2000	4.6	0.5	--	UG/L	150	
1,1-Dichloroethylene	2/28/2000	4.6	0.5	--	UG/L	150	
524.2 TVOC	2/28/2000	19.6	--	--	UG/L	150	
Chloroform	2/28/2000	1.3	0.5	--	UG/L	150	
1,1,1-Trichloroethane	6/16/2000	5.6	0.5	--	UG/L	150	
1,1-Dichloroethane	6/16/2000	4.5	0.5	--	UG/L	150	
1,1-Dichloroethylene	6/16/2000	3.9	0.5	--	UG/L	150	
524.2 TVOC	6/16/2000	15.7	--	--	UG/L	150	
Chloroform	6/16/2000	0.6	0.5	--	UG/L	150	
Trichloroethylene	6/16/2000	1.1	0.5	--	UG/L	150	
1,1,1-Trichloroethane	9/13/2000	7	0.5	--	UG/L	150	
1,1-Dichloroethane	9/13/2000	4.5	0.5	--	UG/L	150	
1,1-Dichloroethylene	9/13/2000	4.3	0.5	--	UG/L	150	
524.2 TVOC	9/13/2000	17.59	--	--	UG/L	150	
Chloroform	9/13/2000	0.92	0.5	--	UG/L	150	
Trichloroethylene	9/13/2000	0.87	0.5	--	UG/L	150	
1,1,1-Trichloroethane	11/30/2000	9.6	0.5	--	UG/L	150	
1,1-Dichloroethane	11/30/2000	3.7	0.5	--	UG/L	150	
1,1-Dichloroethylene	11/30/2000	4.7	0.5	--	UG/L	150	
524.2 TVOC	11/30/2000	19.58	--	--	UG/L	150	
Chloroform	11/30/2000	1.3	0.5	--	UG/L	150	
Trichloroethylene	11/30/2000	0.28	0.5	--	UG/L	150	J
1,1,1-Trichloroethane	2/21/2001	8	0.5	--	UG/L	150	
1,1-Dichloroethane	2/21/2001	3.3	0.5	--	UG/L	150	
1,1-Dichloroethylene	2/21/2001	3.9	0.5	--	UG/L	150	
524.2 TVOC	2/21/2001	16.97	--	--	UG/L	150	
Chloroform	2/21/2001	1.5	0.5	--	UG/L	150	
Trichloroethylene	2/21/2001	0.27	0.5	--	UG/L	150	J
1,1,1-Trichloroethane	5/15/2001	7.2	0.5	--	UG/L	150	
1,1-Dichloroethane	5/15/2001	3.1	0.5	--	UG/L	150	
1,1-Dichloroethylene	5/15/2001	3.8	0.5	--	UG/L	150	
524.2 TVOC	5/15/2001	15.4	--	--	UG/L	150	
Chloroform	5/15/2001	1.3	0.5	--	UG/L	150	
1,1,1-Trichloroethane	8/10/2001	7.8	0.5	--	UG/L	150	
1,1-Dichloroethane	8/10/2001	2.8	0.5	--	UG/L	150	
1,1-Dichloroethylene	8/10/2001	4.1	0.5	--	UG/L	150	
524.2 TVOC	8/10/2001	16.37	--	--	UG/L	150	
Chloroform	8/10/2001	1.4	0.5	--	UG/L	150	
Trichloroethylene	8/10/2001	0.27	0.5	--	UG/L	150	J
Tritium	8/10/2001	389	327	206	PCI/L	150	J-N2
1,1,1-Trichloroethane	10/26/2001	8.9	0.5	--	UG/L	150	
1,1-Dichloroethane	10/26/2001	3.1	0.5	--	UG/L	150	
1,1-Dichloroethylene	10/26/2001	4.5	0.5	--	UG/L	150	
524.2 TVOC	10/26/2001	19.94	--	--	UG/L	150	
Chloroform	10/26/2001	1.6	0.5	--	UG/L	150	
Trichloroethylene	10/26/2001	0.34	0.5	--	UG/L	150	J
Trichlorofluoromethane	10/26/2001	1.5	0.5	--	UG/L	150	

- 2000 TCA
- 2000 -
- 180

- 5
- 180

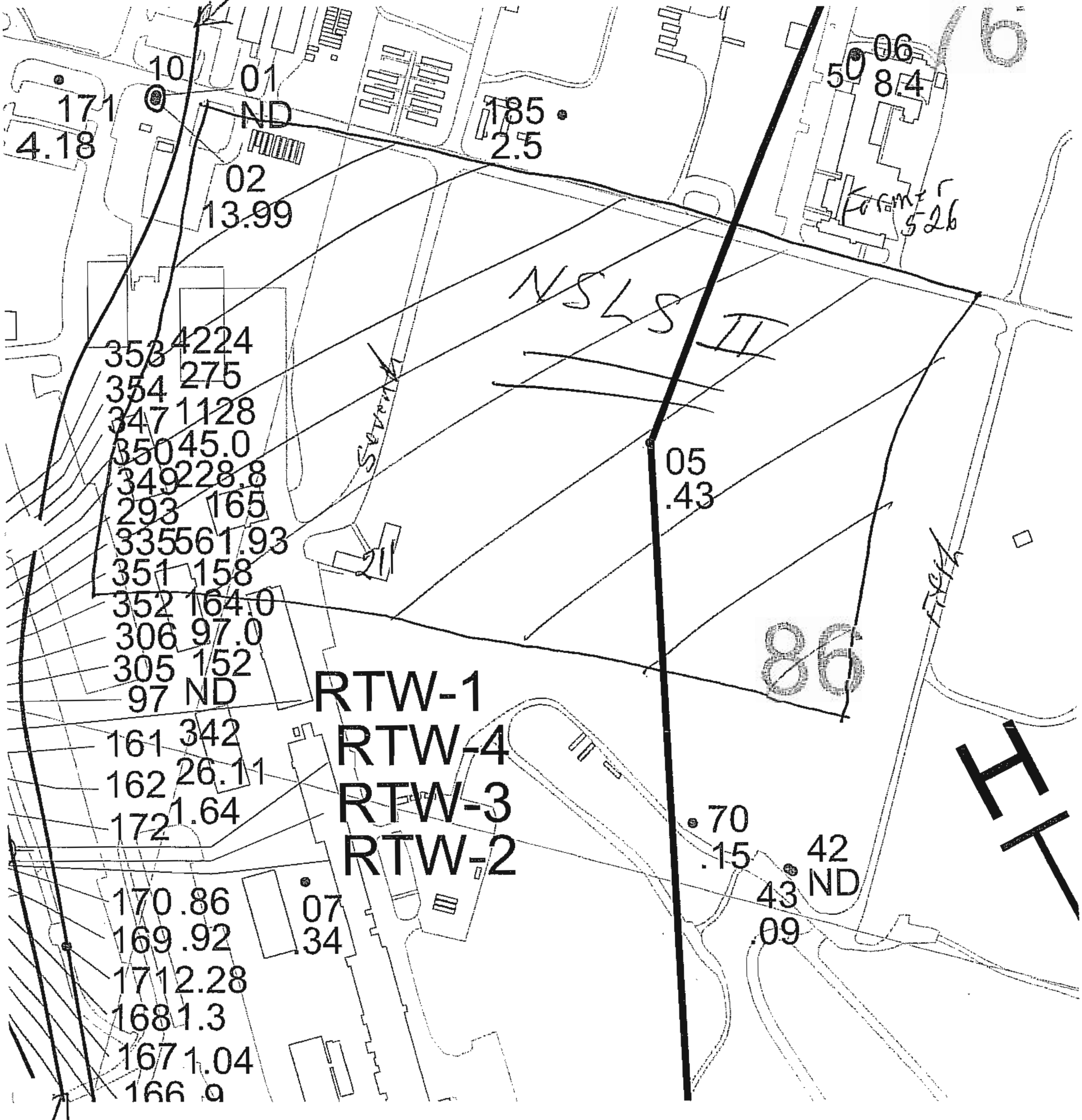
1,1,1-Trichloroethane	1/28/2002	6.2	0.5	--	UG/L	150	
1,1-Dichloroethane	1/28/2002	2.4	0.5	--	UG/L	150	
1,1-Dichloroethylene	1/28/2002	3.4	0.5	--	UG/L	150	
524.2 TVOC	1/28/2002	13.1	--	--	UG/L	150	
Chloroform	1/28/2002	1.1	0.5	--	UG/L	150	
1,1,1-Trichloroethane	4/30/2002	7	0.5	--	UG/L	150	
1,1-Dichloroethane	4/30/2002	2.9	0.5	--	UG/L	150	
1,1-Dichloroethylene	4/30/2002	3.6	0.5	--	UG/L	150	
524.2 TVOC	4/30/2002	15.3	--	--	UG/L	150	
Chloroform	4/30/2002	1.3	0.5	--	UG/L	150	
Trichloroethylene	4/30/2002	0.5	0.5	--	UG/L	150	
1,1,1-Trichloroethane	7/30/2002	6.4	0.5	--	UG/L	150	
1,1-Dichloroethane	7/30/2002	2.8	0.5	--	UG/L	150	
1,1-Dichloroethylene	7/30/2002	3.2	0.5	--	UG/L	150	
524.2 TVOC	7/30/2002	14.1	--	--	UG/L	150	
Chloroform	7/30/2002	1.4	0.5	--	UG/L	150	
Trichloroethylene	7/30/2002	0.3	0.5	--	UG/L	150	J
1,1,1-Trichloroethane	11/26/2002	7.8	0.5	--	UG/L	150	
1,1-Dichloroethane	11/26/2002	2.9	0.5	--	UG/L	150	
1,1-Dichloroethylene	11/26/2002	3.5	0.5	--	UG/L	150	
524.2 TVOC	11/26/2002	15.97	--	--	UG/L	150	
Chloroform	11/26/2002	1.5	0.5	--	UG/L	150	
Trichloroethylene	11/26/2002	0.27	0.5	--	UG/L	150	J
1,1,1-Trichloroethane	2/20/2003	6	0.5	--	UG/L	150	
1,1-Dichloroethane	2/20/2003	2.5	0.5	--	UG/L	150	
1,1-Dichloroethylene	2/20/2003	3.3	0.5	--	UG/L	150	
524.2 TVOC	2/20/2003	13.5	--	--	UG/L	150	
Carbon tetrachloride	2/20/2003	0.6	0.5	--	UG/L	150	
Chloroform	2/20/2003	1.1	0.5	--	UG/L	150	
1,1,1-Trichloroethane	6/9/2003	6.2	0.5	--	UG/L	150	
1,1-Dichloroethane	6/9/2003	2.3	0.5	--	UG/L	150	
1,1-Dichloroethylene	6/9/2003	3.3	0.5	--	UG/L	150	
524.2 TVOC	6/9/2003	13.1	--	--	UG/L	150	
Chloroform	6/9/2003	1.3	0.5	--	UG/L	150	
1,1,1-Trichloroethane	9/10/2003	6.2	0.5	--	UG/L	150	
1,1-Dichloroethylene	9/10/2003	3.2	0.5	--	UG/L	150	
524.2 TVOC	9/10/2003	11	--	--	UG/L	150	
Chloroform	9/10/2003	1.6	0.5	--	UG/L	150	
1,1,1-Trichloroethane	12/12/2003	5.3	0.5	--	UG/L	150	
1,1-Dichloroethane	12/12/2003	2.1	0.5	--	UG/L	150	
1,1-Dichloroethylene	12/12/2003	3.4	0.5	--	UG/L	150	
524.2 TVOC	12/12/2003	12.2	--	--	UG/L	150	
Chloroform	12/12/2003	1.4	0.5	--	UG/L	150	
1,1,1-Trichloroethane	11/8/2004	3.2	0.5	--	UG/L	150	
1,1-Dichloroethane	11/8/2004	1.9	0.5	--	UG/L	150	
1,1-Dichloroethylene	11/8/2004	1.9	0.5	--	UG/L	150	
524.2 TVOC	11/8/2004	8.77	--	--	UG/L	150	
Chloroform	11/8/2004	1.4	0.5	--	UG/L	150	
Trichloroethylene	11/8/2004	0.37	0.5	--	UG/L	150	J
1,1,1-Trichloroethane	11/8/2005	3.3	0.5	--	UG/L	150	
1,1-Dichloroethane	11/8/2005	2.1	0.5	--	UG/L	150	
1,1-Dichloroethylene	11/8/2005	2.1	0.5	--	UG/L	150	

524.2 TVOC	11/8/2005	8.93	--	--	UG/L	150	
Chloroform	11/8/2005	1.1	0.5	--	UG/L	150	
Trichloroethylene	11/8/2005	0.33	0.5	--	UG/L	150	J

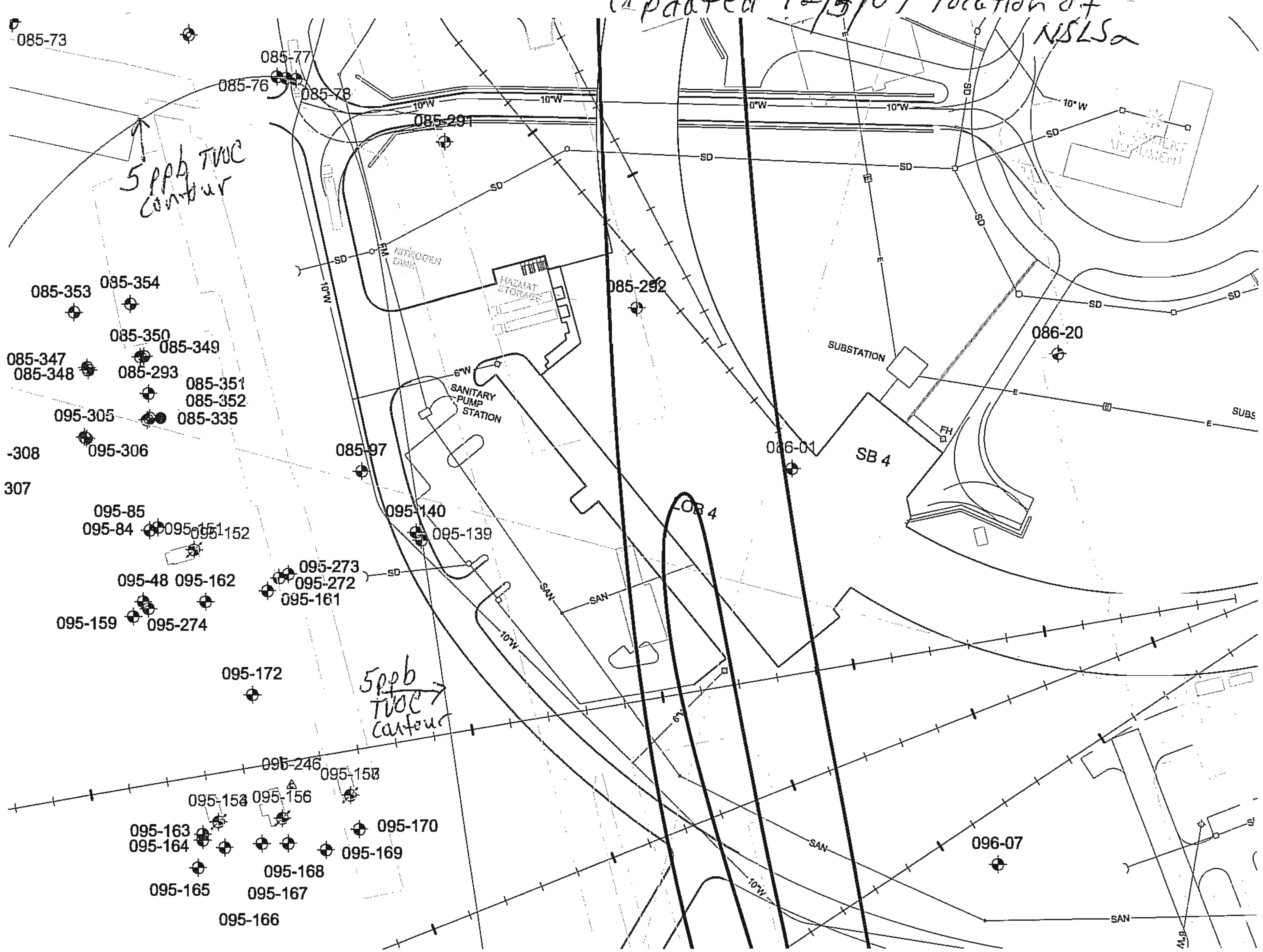
Site ID: 084-05

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
524.2 TVOC	2/25/2000	0	--	--	UG/L	184	
524.2 TVOC	6/16/2000	0	--	--	UG/L	184	
Strontium-90	6/16/2000	-0.497	0.83	0.389	PCI/L	184	DL
524.2 TVOC	9/13/2000	0	--	--	UG/L	184	
524.2 TVOC	12/1/2000	0.28	--	--	UG/L	184	
Methylene chloride	12/1/2000	0.28	0.5	--	UG/L	184	J
524.2 TVOC	2/21/2001	0	--	--	UG/L	184	
524.2 TVOC	5/15/2001	0	--	--	UG/L	184	
524.2 TVOC	8/9/2001	0	--	--	UG/L	184	
524.2 TVOC	10/26/2001	0.37	--	--	UG/L	184	
524.2 TVOC	1/28/2002	0	--	--	UG/L	184	
524.2 TVOC	4/30/2002	0	--	--	UG/L	184	
524.2 TVOC	7/30/2002	0	--	--	UG/L	184	
524.2 TVOC	12/6/2002	0.31	--	--	UG/L	184	
Toluene	12/6/2002	0.31	0.5	--	UG/L	184	J
524.2 TVOC	2/20/2003	0	--	--	UG/L	184	
524.2 TVOC	6/9/2003	0	--	--	UG/L	184	
524.2 TVOC	9/9/2003	0	--	--	UG/L	184	
524.2 TVOC	12/12/2003	0	--	--	UG/L	184	
524.2 TVOC	11/8/2004	0.076	--	--	UG/L	184	
Chloroform	11/8/2004	0.076	0.5	--	UG/L	184	J
524.2 TVOC	11/8/2005	0	--	--	UG/L	184	

5 ppb TVOC



10 ppb TVOC


Updated 12/5/07 location of NSLs
5ppb TVOC contour
5ppb TVOC contour
085-73
085-77
085-76
085-78
085-291
085-292
086-20
086-01
085-97
085-353
085-354
085-350
085-349
085-347
085-348
085-293
085-351
085-352
095-305
085-335
095-306
-308
307
095-85
095-84
095-151
095-152
095-140
095-139
095-273
095-272
095-161
095-48
095-162
095-159
095-274
095-172
095-246
095-157
095-153
095-156
095-163
095-164
095-170
095-169
095-168
095-165
095-167
095-166
096-07
SB 4
OB 4
SUBSTATION
SANITARY PUMP STATION
NITROGEN TANK
HAZMAT STORAGE
FH
FM
SD
SAN
E
SUBS
10"W
6"W

NSLS II Monitor Wells

9/12/2006

Site ID: 076-06

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
524.2 TVOC	2/4/2000	14.47	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	2/4/2000	3.4	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	2/4/2000	5	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	2/4/2000	0.66	0.5	--	UG/L	40	
Cymene	2/4/2000	0.71	0.5	--	UG/L	40	
n-Butylbenzene	2/4/2000	0.5	0.5	--	UG/L	40	
n-Propylbenzene	2/4/2000	1.4	0.5	--	UG/L	40	
sec-Butylbenzene	2/4/2000	1.2	0.5	--	UG/L	40	
Tetrachloroethylene	2/4/2000	1.6	0.5	--	UG/L	40	
524.2 TVOC	6/30/2000	7.39	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	6/30/2000	1.9	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	6/30/2000	2.8	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	6/30/2000	0.33	0.5	--	UG/L	40	J
Cymene	6/30/2000	0.52	0.5	--	UG/L	40	
n-Propylbenzene	6/30/2000	0.66	0.5	--	UG/L	40	
sec-Butylbenzene	6/30/2000	0.44	0.5	--	UG/L	40	J
Tetrachloroethylene	6/30/2000	0.74	0.5	--	UG/L	40	
524.2 TVOC	7/31/2000	7.46	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	7/31/2000	1.8	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	7/31/2000	2.6	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	7/31/2000	0.38	0.5	--	UG/L	40	J
Chloroform	7/31/2000	0.25	0.5	--	UG/L	40	J
Cymene	7/31/2000	0.48	0.5	--	UG/L	40	J
n-Propylbenzene	7/31/2000	0.65	0.5	--	UG/L	40	
sec-Butylbenzene	7/31/2000	0.42	0.5	--	UG/L	40	J
Tetrachloroethylene	7/31/2000	0.88	0.5	--	UG/L	40	
1-Methylnaphthalene	10/25/2000	5.6	9.7	--	UG/L	40	J
2-Methylnaphthalene	10/25/2000	1.5	9.7	--	UG/L	40	J
524.2 TVOC	10/25/2000	12.82	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	10/25/2000	2.9	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	10/25/2000	2.8	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	10/25/2000	0.83	0.5	--	UG/L	40	
Cymene	10/25/2000	0.89	0.5	--	UG/L	40	
Naphthalene	10/25/2000	1.4	0.5	--	UG/L	40	
n-Propylbenzene	10/25/2000	1.3	0.5	--	UG/L	40	
sec-Butylbenzene	10/25/2000	0.9	0.5	--	UG/L	40	
Tetrachloroethylene	10/25/2000	1.8	0.5	--	UG/L	40	
524.2 TVOC	1/26/2001	16.09	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	1/26/2001	5.3	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	1/26/2001	4.4	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	1/26/2001	1.1	0.5	--	UG/L	40	
Cymene	1/26/2001	0.56	0.5	--	UG/L	40	
Naphthalene	1/26/2001	0.28	0.5	--	UG/L	40	J
n-Butylbenzene	1/26/2001	0.31	0.5	--	UG/L	40	J
n-Propylbenzene	1/26/2001	1.6	0.5	--	UG/L	40	
sec-Butylbenzene	1/26/2001	0.84	0.5	--	UG/L	40	
Tetrachloroethylene	1/26/2001	1.7	0.5	--	UG/L	40	
1-Methylnaphthalene	5/9/2001	1.2	0.97	--	UG/L	40	

2-Methylnaphthalene	5/9/2001	0.6	0.97	--	UG/L	40	J
524.2 TVOC	5/9/2001	3.7	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	5/9/2001	1	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	5/9/2001	0.93	0.5	--	UG/L	40	
Chloroform	5/9/2001	1.1	0.5	--	UG/L	40	
n-Propylbenzene	5/9/2001	0.37	0.5	--	UG/L	40	J
Tetrachloroethylene	5/9/2001	0.3	0.5	--	UG/L	40	J
524.2 TVOC	7/25/2001	1.08	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	7/25/2001	0.52	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	7/25/2001	0.27	0.5	--	UG/L	40	J
Tetrachloroethylene	7/25/2001	0.29	0.5	--	UG/L	40	J
1-Methylnaphthalene	11/7/2001	19.8	0.98	--	UG/L	40	
2-Chloronaphthalene	11/7/2001	0.21	9.8	--	UG/L	40	J
2-Methylnaphthalene	11/7/2001	13.6	0.98	--	UG/L	40	
524.2 TVOC	11/7/2001	13.05	--	--	UG/L	40	
Acenaphthene	11/7/2001	1.4	9.8	--	UG/L	40	J
Benzene, 1,2,4-trimethyl	11/7/2001	2.9	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	11/7/2001	4.5	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	11/7/2001	0.7	0.5	--	UG/L	40	
Bis(2-ethylhexyl)phthalate	11/7/2001	0.19	9.8	--	UG/L	40	J
Cymene	11/7/2001	0.9	0.5	--	UG/L	40	
Dibenzofuran	11/7/2001	1.3	9.8	--	UG/L	40	J
Fluorene	11/7/2001	2.7	9.8	--	UG/L	40	J
Naphthalene	11/7/2001	0.31	0.5	--	UG/L	40	J
n-Propylbenzene	11/7/2001	1.3	0.5	--	UG/L	40	
Phenanthrene	11/7/2001	1.1	9.8	--	UG/L	40	J
sec-Butylbenzene	11/7/2001	1	0.5	--	UG/L	40	
tert-Butylbenzene	11/7/2001	0.34	0.5	--	UG/L	40	J
Tetrachloroethylene	11/7/2001	1.1	0.5	--	UG/L	40	
1-Methylnaphthalene	2/12/2002	22.2	0.97	--	UG/L	40	
2-Methylnaphthalene	2/12/2002	20.2	0.97	--	UG/L	40	
524.2 TVOC	2/12/2002	9.18	--	--	UG/L	40	
Acenaphthene	2/12/2002	1.5	9.7	--	UG/L	40	J
Benzene, 1,2,4-trimethyl	2/12/2002	1.5	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	2/12/2002	3	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	2/12/2002	0.35	0.5	--	UG/L	40	J
Cymene	2/12/2002	0.86	0.5	--	UG/L	40	
Dibenzofuran	2/12/2002	1.3	9.7	--	UG/L	40	J
Diethyl phthalate	2/12/2002	1.3	9.7	--	UG/L	40	J
Fluorene	2/12/2002	2.8	9.7	--	UG/L	40	J
Methylene chloride	2/12/2002	0.48	0.5	--	UG/L	40	J
n-Propylbenzene	2/12/2002	0.73	0.5	--	UG/L	40	
Phenanthrene	2/12/2002	1.4	9.7	--	UG/L	40	J
sec-Butylbenzene	2/12/2002	0.71	0.5	--	UG/L	40	
Tetrachloroethylene	2/12/2002	1.2	0.5	--	UG/L	40	
1-Methylnaphthalene	5/13/2002	24.1	0.96	--	UG/L	40	
2-Methylnaphthalene	5/13/2002	13.1	0.96	--	UG/L	40	
524.2 TVOC	5/13/2002	29	--	--	UG/L	40	
Acenaphthene	5/13/2002	2.1	9.6	--	UG/L	40	J
Benzene, 1,2,4-trimethyl	5/13/2002	4.8	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	5/13/2002	10.4	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	5/13/2002	1.1	0.5	--	UG/L	40	

Cymene	5/13/2002	2.8	0.5	--	UG/L	40	
Dibenzofuran	5/13/2002	2.1	9.6	--	UG/L	40	J
Fluorene	5/13/2002	4	9.6	--	UG/L	40	J
n-Butylbenzene	5/13/2002	2.8	0.5	--	UG/L	40	
n-Propylbenzene	5/13/2002	2.7	0.5	--	UG/L	40	
Phenanthrene	5/13/2002	0.98	9.6	--	UG/L	40	J
tert-Butylbenzene	5/13/2002	1.1	0.5	--	UG/L	40	
Tetrachloroethylene	5/13/2002	2.4	0.5	--	UG/L	40	
1-Methylnaphthalene	8/9/2002	15.2	0.96	--	UG/L	40	
2-Methylnaphthalene	8/9/2002	4.2	0.96	--	UG/L	40	
524.2 TVOC	8/9/2002	24.1	--	--	UG/L	40	
Acenaphthene	8/9/2002	1.8	9.6	--	UG/L	40	J
Benzene, 1,2,4-trimethyl	8/9/2002	5.8	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	8/9/2002	9.1	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	8/9/2002	1.4	0.5	--	UG/L	40	
Cymene	8/9/2002	2.8	0.5	--	UG/L	40	
Dibenzofuran	8/9/2002	1.5	9.6	--	UG/L	40	J
Fluorene	8/9/2002	3	9.6	--	UG/L	40	J
n-Propylbenzene	8/9/2002	2.6	0.5	--	UG/L	40	
Tetrachloroethylene	8/9/2002	2.4	0.5	--	UG/L	40	
524.2 TVOC	10/29/2002	13.41	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	10/29/2002	2	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	10/29/2002	5.1	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	10/29/2002	0.41	0.5	--	UG/L	40	J
Cymene	10/29/2002	2.2	0.5	--	UG/L	40	
n-Propylbenzene	10/29/2002	1.1	0.5	--	UG/L	40	
Tetrachloroethylene	10/29/2002	2.6	0.5	--	UG/L	40	
524.2 TVOC	1/30/2003	4.02	--	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	1/30/2003	0.7	0.5	--	UG/L	40	
Cymene	1/30/2003	0.77	0.5	--	UG/L	40	
Methylene chloride	1/30/2003	0.36	0.5	--	UG/L	40	J
n-Propylbenzene	1/30/2003	0.31	0.5	--	UG/L	40	J
sec-Butylbenzene	1/30/2003	0.48	0.5	--	UG/L	40	J
Tetrachloroethylene	1/30/2003	1.4	0.5	--	UG/L	40	
524.2 TVOC	5/27/2003	1.24	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	5/27/2003	0.33	0.5	--	UG/L	40	J
Benzene, 1,3,5-trimethyl-	5/27/2003	0.52	0.5	--	UG/L	40	
Tetrachloroethylene	5/27/2003	0.39	0.5	--	UG/L	40	J
524.2 TVOC	8/21/2003	2.27	--	--	UG/L	40	
524.2 TVOC	8/21/2003	1.12	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	8/21/2003	0.54	0.5	--	UG/L	40	
Benzene, 1,2,4-trimethyl	8/21/2003	0.45	0.5	--	UG/L	40	J
Benzene, 1,3,5-trimethyl-	8/21/2003	0.58	0.5	--	UG/L	40	
cis-1,2-Dichloroethylene	8/21/2003	0.64	0.5	--	UG/L	40	
Ethylbenzene	8/21/2003	0.4	0.5	--	UG/L	40	J
m/p xylene	8/21/2003	0.36	0.5	--	UG/L	40	J
Naphthalene	8/21/2003	0.42	0.5	--	UG/L	40	J
524.2 TVOC	12/30/2003	11.48	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	12/30/2003	2.7	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	12/30/2003	3.7	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	12/30/2003	0.66	0.5	--	UG/L	40	
Cymene	12/30/2003	1.9	0.5	--	UG/L	40	

n-Propylbenzene	12/30/2003	1.1	0.5	--	UG/L	40	
sec-Butylbenzene	12/30/2003	0.62	0.5	--	UG/L	40	
Tetrachloroethylene	12/30/2003	0.8	0.5	--	UG/L	40	
524.2 TVOC	3/8/2004	1.92	—	--	UG/L	40	
Benzene, 1,2,4-trimethyl	3/8/2004	0.76	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	3/8/2004	0.65	0.5	--	UG/L	40	
Tetrachloroethylene	3/8/2004	0.51	0.5	--	UG/L	40	
524.2 TVOC	6/28/2004	0	--	--	UG/L	40	
524.2 TVOC	8/20/2004	3.23	—	--	UG/L	40	
Benzene, 1,2,4-trimethyl	8/20/2004	0.82	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	8/20/2004	1.2	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	8/20/2004	0.24	0.5	--	UG/L	40	J
Cymene	8/20/2004	0.21	0.5	--	UG/L	40	J
n-Propylbenzene	8/20/2004	0.43	0.5	--	UG/L	40	J
Tetrachloroethylene	8/20/2004	0.33	0.5	--	UG/L	40	J
524.2 TVOC	10/27/2004	15.85	—	--	UG/L	40	
Benzene, 1,2,4-trimethyl	10/27/2004	3.2	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	10/27/2004	5.7	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	10/27/2004	0.68	0.5	--	UG/L	40	
Cymene	10/27/2004	1.6	0.5	--	UG/L	40	
n-Butylbenzene	10/27/2004	0.56	0.5	--	UG/L	40	
n-Propylbenzene	10/27/2004	1.4	0.5	--	UG/L	40	
sec-Butylbenzene	10/27/2004	1.3	0.5	--	UG/L	40	
tert-Butylbenzene	10/27/2004	0.31	0.5	--	UG/L	40	J
Tetrachloroethylene	10/27/2004	1.1	0.5	--	UG/L	40	
524.2 TVOC	2/4/2005	16.71	—	--	UG/L	40	
Benzene, 1,2,4-trimethyl	2/4/2005	4.8	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	2/4/2005	5	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	2/4/2005	0.86	0.5	--	UG/L	40	
Cymene	2/4/2005	1.7	0.5	--	UG/L	40	
n-Propylbenzene	2/4/2005	1.3	0.5	--	UG/L	40	
sec-Butylbenzene	2/4/2005	1.3	0.5	--	UG/L	40	
tert-Butylbenzene	2/4/2005	0.35	0.5	--	UG/L	40	J
Tetrachloroethylene	2/4/2005	1.4	0.5	--	UG/L	40	
524.2 TVOC	6/29/2005	9	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	6/29/2005	2.4	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	6/29/2005	3.7	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	6/29/2005	0.44	0.5	--	UG/L	40	J
n-Propylbenzene	6/29/2005	1	0.5	--	UG/L	40	
sec-Butylbenzene	6/29/2005	0.72	0.5	--	UG/L	40	
tert-Butylbenzene	6/29/2005	0.13	0.5	--	UG/L	40	J
Tetrachloroethylene	6/29/2005	0.61	0.5	--	UG/L	40	
524.2 TVOC	8/31/2005	0.5	—	--	UG/L	40	
Tetrachloroethylene	8/31/2005	0.5	0.5	--	UG/L	40	
524.2 TVOC	12/8/2005	8.4	--	--	UG/L	60	
Benzene, 1,2,4-trimethyl	12/8/2005	2.4	0.5	--	UG/L	60	
Benzene, 1,3,5-trimethyl-	12/8/2005	1.8	0.5	--	UG/L	60	
Benzene, 1-methylethyl-	12/8/2005	0.43	0.5	--	UG/L	60	J
Bis(2-ethylhexyl)phthalate	12/8/2005	4.5	10	--	UG/L	60	J
Butyl benzyl phthalate	12/8/2005	6.2	10	--	UG/L	60	J
Cymene	12/8/2005	1.3	0.5	--	UG/L	60	
Di-n-octyl phthalate	12/8/2005	3.2	10	--	UG/L	60	J

n-Propylbenzene	12/8/2005	0.74	0.5	--	UG/L	60	
sec-Butylbenzene	12/8/2005	0.72	0.5	--	UG/L	60	
tert-Butylbenzene	12/8/2005	0.17	0.5	--	UG/L	60	J
Tetrachloroethylene	12/8/2005	0.84	0.5	--	UG/L	60	
524.2 TVOC	3/2/2006	7.95	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	3/2/2006	2.2	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	3/2/2006	3.2	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	3/2/2006	0.43	0.5	--	UG/L	40	J
Cymene	3/2/2006	0.47	0.5	--	UG/L	40	J
n-Propylbenzene	3/2/2006	0.78	0.5	--	UG/L	40	
sec-Butylbenzene	3/2/2006	0.49	0.5	--	UG/L	40	J
Tetrachloroethylene	3/2/2006	0.38	0.5	--	UG/L	40	J
524.2 TVOC	5/1/2006	5.591	--	--	UG/L	40	
Benzene, 1,2,4-trimethyl	5/1/2006	1.6	0.5	--	UG/L	40	
Benzene, 1,3,5-trimethyl-	5/1/2006	1.6	0.5	--	UG/L	40	
Benzene, 1-methylethyl-	5/1/2006	0.23	0.5	--	UG/L	40	J
Cymene	5/1/2006	0.69	0.5	--	UG/L	40	
n-Propylbenzene	5/1/2006	0.49	0.5	--	UG/L	40	J
sec-Butylbenzene	5/1/2006	0.38	0.5	--	UG/L	40	J
tert-Butylbenzene	5/1/2006	0.091	0.5	--	UG/L	40	J
Tetrachloroethylene	5/1/2006	0.51	0.5	--	UG/L	40	
Benzene, 1,2,4-trimethyl	8/8/2006	0.11	0.5	--	UG/L	40	J
Benzene, 1,3,5-trimethyl-	8/8/2006	0.083	0.5	--	UG/L	40	J
Tetrachloroethylene	8/8/2006	0.18	0.5	--	UG/L	40	J

Site ID: 076-185

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
524.2 TVOC	2/4/2000	0.79	--	--	UG/L	60	
Chloroform	2/4/2000	0.49	0.5	--	UG/L	60	J
Tetrachloroethylene	2/4/2000	0.3	0.5	--	UG/L	60	J
524.2 TVOC	6/29/2000	21.4	--	--	UG/L	25	
cis-1,2-Dichloroethylene	6/29/2000	20.2	0.5	--	UG/L	25	
Gross Beta	6/29/2000	2.26	0.815	0.511	PCI/L	25	J
Strontium-90	6/29/2000	1.64	0.331	0.236	PCI/L	25	
Tetrachloroethylene	6/29/2000	1.2	0.5	--	UG/L	25	
524.2 TVOC	7/31/2000	14.3	--	--	UG/L	25	
cis-1,2-Dichloroethylene	7/31/2000	13.1	0.5	--	UG/L	25	
Tetrachloroethylene	7/31/2000	1.2	0.5	--	UG/L	25	
524.2 TVOC	10/23/2000	9.29	--	--	UG/L	25	
cis-1,2-Dichloroethylene	10/23/2000	7.1	0.5	--	UG/L	25	
Methylene chloride	10/23/2000	0.89	0.5	--	UG/L	25	
Tetrachloroethylene	10/23/2000	1.3	0.5	--	UG/L	25	
524.2 TVOC	1/26/2001	3.5	--	--	UG/L	25	
cis-1,2-Dichloroethylene	1/26/2001	2.2	0.5	--	UG/L	25	
Tetrachloroethylene	1/26/2001	1.3	0.5	--	UG/L	25	
524.2 TVOC	5/9/2001	1.51	--	--	UG/L	40	
cis-1,2-Dichloroethylene	5/9/2001	0.59	0.5	--	UG/L	40	
Tetrachloroethylene	5/9/2001	0.64	0.5	--	UG/L	40	
Toluene	5/9/2001	0.28	0.5	--	UG/L	40	J
524.2 TVOC	7/24/2001	0.48	--	--	UG/L	25	
Tetrachloroethylene	7/24/2001	0.48	0.5	--	UG/L	25	J
524.2 TVOC	11/8/2001	0.66	--	--	UG/L	40	

Bis(2-ethylhexyl)phthalate	11/8/2001	0.43	10	--	UG/L	40	J
Tetrachloroethylene	11/8/2001	0.66	0.5	--	UG/L	40	
524.2 TVOC	2/12/2002	1.5	--	--	UG/L	25	
Methylene chloride	2/12/2002	0.61	0.5	--	UG/L	25	
Tetrachloroethylene	2/12/2002	0.57	0.5	--	UG/L	25	
1,1,1-Trichloroethane	5/14/2002	0.35	0.5	--	UG/L	25	J
524.2 TVOC	5/14/2002	32.67	--	--	UG/L	25	
cis-1,2-Dichloroethylene	5/14/2002	26.6	0.5	--	UG/L	25	
Tetrachloroethylene	5/14/2002	3.4	0.5	--	UG/L	25	
Trichloroethylene	5/14/2002	0.82	0.5	--	UG/L	25	
524.2 TVOC	8/7/2002	7.16	--	--	UG/L	25	
cis-1,2-Dichloroethylene	8/7/2002	5.6	0.5	--	UG/L	25	
Tetrachloroethylene	8/7/2002	1.3	0.5	--	UG/L	25	
Trichloroethylene	8/7/2002	0.26	0.5	--	UG/L	25	J
1,1,1-Trichloroethane	10/30/2002	0.46	0.5	--	UG/L	25	J
524.2 TVOC	10/30/2002	27.16	--	--	UG/L	25	
cis-1,2-Dichloroethylene	10/30/2002	19.7	0.5	--	UG/L	25	
Tetrachloroethylene	10/30/2002	5.9	0.5	--	UG/L	25	
Trichloroethylene	10/30/2002	1.1	0.5	--	UG/L	25	
1,1,1-Trichloroethane	1/31/2003	0.35	0.5	--	UG/L	25	J
524.2 TVOC	1/31/2003	24.96	--	--	UG/L	25	
cis-1,2-Dichloroethylene	1/31/2003	19.3	0.5	--	UG/L	25	
Tetrachloroethylene	1/31/2003	4.5	0.5	--	UG/L	25	
Trichloroethylene	1/31/2003	0.81	0.5	--	UG/L	25	
524.2 TVOC	5/22/2003	2.7	--	--	UG/L	25	
cis-1,2-Dichloroethylene	5/22/2003	1.7	0.5	--	UG/L	25	
Tetrachloroethylene	5/22/2003	1	0.5	--	UG/L	25	
524.2 TVOC	8/21/2003	1.49	--	--	UG/L	25	
Chloroform	8/21/2003	0.64	0.5	--	UG/L	25	
cis-1,2-Dichloroethylene	8/21/2003	0.32	0.5	--	UG/L	25	J
Tetrachloroethylene	8/21/2003	0.53	0.5	--	UG/L	25	
524.2 TVOC	12/29/2003	1.87	--	--	UG/L	25	
cis-1,2-Dichloroethylene	12/29/2003	0.77	0.5	--	UG/L	25	
Tetrachloroethylene	12/29/2003	1.1	0.5	--	UG/L	25	
524.2 TVOC	3/8/2004	6.5	--	--	UG/L	25	
cis-1,2-Dichloroethylene	3/8/2004	3.9	0.5	--	UG/L	25	
Tetrachloroethylene	3/8/2004	2.6	0.5	--	UG/L	25	
524.2 TVOC	6/28/2004	2.1	--	--	UG/L	25	
Tetrachloroethylene	6/28/2004	2.1	0.5	--	UG/L	25	
524.2 TVOC	8/30/2004	6.48	--	--	UG/L	25	
cis-1,2-Dichloroethylene	8/30/2004	4.2	0.5	--	UG/L	25	
Tetrachloroethylene	8/30/2004	2	0.5	--	UG/L	25	
Trichloroethylene	8/30/2004	0.28	0.5	--	UG/L	25	J
1,1,1-Trichloroethane	10/26/2004	0.23	0.5	--	UG/L	25	J
524.2 TVOC	10/26/2004	15.84	--	--	UG/L	25	
cis-1,2-Dichloroethylene	10/26/2004	10	0.5	--	UG/L	25	
Tetrachloroethylene	10/26/2004	4.8	0.5	--	UG/L	25	
Trichloroethylene	10/26/2004	0.81	0.5	--	UG/L	25	
524.2 TVOC	2/4/2005	9.66	--	--	UG/L	25	
cis-1,2-Dichloroethylene	2/4/2005	6.3	0.5	--	UG/L	25	
Tetrachloroethylene	2/4/2005	2.9	0.5	--	UG/L	25	
Trichloroethylene	2/4/2005	0.46	0.5	--	UG/L	25	J

524.2 TVOC	8/31/2005	2.5	--	--	UG/L	25	
cis-1,2-Dichloroethylene	8/31/2005	1.2	0.5	--	UG/L	25	
Tetrachloroethylene	8/31/2005	1.3	0.5	--	UG/L	25	
524.2 TVOC	3/10/2006	0.873	--	--	UG/L	25	
Chloroform	3/10/2006	0.14	0.5	--	UG/L	25	J
cis-1,2-Dichloroethylene	3/10/2006	0.29	0.5	--	UG/L	25	J
Tetrachloroethylene	3/10/2006	0.36	0.5	--	UG/L	25	J
Trichlorofluoromethane	3/10/2006	0.083	0.5	--	UG/L	25	J
Chloroform	8/8/2006	0.11	0.5	--	UG/L	25	J
cis-1,2-Dichloroethylene	8/8/2006	0.23	0.5	--	UG/L	25	J
Methyl chloride	8/8/2006	0.1	0.5	--	UG/L	25	J
Tetrachloroethylene	8/8/2006	0.32	0.5	--	UG/L	25	J
Trichlorofluoromethane	8/8/2006	0.084	0.5	--	UG/L	25	J

Site ID: 085-01

Chemical Name	**Sample Date**	**Value**	**Det. Limit**	**Error**	**Units**	**Depth**	**Qual.**
1,1,1-Trichloroethane	1/12/2000	0.54	0.5	--	UG/L	75	
1,1-Dichloroethylene	1/12/2000	0.5	0.5	--	UG/L	75	J
524.2 TVOC	1/12/2000	4.71	--	--	UG/L	75	
Benzene	1/12/2000	0.5	0.5	--	UG/L	75	JB
Benzene, 1,2,4-trimethyl	1/12/2000	0.5	0.5	--	UG/L	75	JB
Chloroform	1/12/2000	0.67	0.5	--	UG/L	75	
m/p xylene	1/12/2000	0.5	0.5	--	UG/L	75	JB
Toluene	1/12/2000	0.5	0.5	--	UG/L	75	JB
Trichloroethylene	1/12/2000	0.5	0.5	--	UG/L	75	J
Trichlorofluoromethane	1/12/2000	0.5	0.5	--	UG/L	75	JB
1,1,1-Trichloroethane	7/5/2000	6.3	0.5	--	UG/L	75	
1,1-Dichloroethylene	7/5/2000	2.6	0.5	--	UG/L	75	
524.2 TVOC	7/5/2000	9.32	--	--	UG/L	75	
Chloroform	7/5/2000	0.42	0.5	--	UG/L	75	J
Gross Beta	8/1/2000	3.49	2.28	2.94	PCI/L	75	
Tritium	8/1/2000	1450	320	538	PCI/L	75	
Tritium	10/6/2000	547	508	315	PCI/L	75	JN2
1,1,1-Trichloroethane	1/9/2001	0.62	0.5	--	UG/L	75	
1,1-Dichloroethylene	1/9/2001	0.26	0.5	--	UG/L	75	J
524.2 TVOC	1/9/2001	1.19	--	--	UG/L	75	
Chloroform	1/9/2001	0.31	0.5	--	UG/L	75	J
1,1,1-Trichloroethane	7/3/2001	0.5	0.5	--	UG/L	85	
524.2 TVOC	7/3/2001	1.38	--	--	UG/L	85	
Toluene	7/3/2001	0.88	0.5	--	UG/L	85	
524.2 TVOC	10/8/2001	0	--	--	UG/L	75	
Tritium	4/11/2002	1340	448	321	PCI/L	75	
Tritium	7/10/2002	1400	523	362	PCI/L	75	
524.2 TVOC	10/10/2002	0	--	--	UG/L	75	
Tritium	10/10/2002	10200	381	516	PCI/L	75	
Tritium	1/9/2003	2290	405	330	PCI/L	75	
Tritium	4/24/2003	392	276	215	PCI/L	75	
524.2 TVOC	10/27/2003	0	--	--	UG/L	75	
Tritium	10/27/2003	287	271	180	PCI/L	75	
Tritium	1/29/2004	310	260	190	PCI/L	75	J
524.2 TVOC	10/6/2004	0.94	--	--	UG/L	75	
Chloroform	10/6/2004	0.2	0.5	--	UG/L	75	J

Methylene chloride	10/6/2004	0.74	0.5	–	UG/L	75	
Tritium	4/1/2005	2170	180	380	PCI/L	75	
524.2 TVOC	10/7/2005	0	--	–	UG/L	75	
Tritium	10/7/2005	2560	470	480	PCI/L	75	J(-)-S
Tritium	1/13/2006	3480	340	490	PCI/L	75	
Tritium	4/11/2006	1370	380	320	PCI/L	75	
Tritium	7/19/2006	2460	350	400	PCI/L	75	

Site ID: 085-02

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
1,1,1-Trichloroethane	1/12/2000	3	0.5	--	UG/L	145	
1,1-Dichloroethane	1/12/2000	0.5	0.5	--	UG/L	145	J
1,1-Dichloroethylene	1/12/2000	0.86	0.5	--	UG/L	145	
1,2-Dichloroethane	1/12/2000	0.5	0.5	--	UG/L	145	J
524.2 TVOC	1/12/2000	6.24	--	--	UG/L	145	
Chloroform	1/12/2000	0.88	0.5	--	UG/L	145	
Trichloroethylene	1/12/2000	0.5	0.5	--	UG/L	145	J
1,1,1-Trichloroethane	7/5/2000	5.6	0.5	--	UG/L	145	
1,1-Dichloroethylene	7/5/2000	1.8	0.5	--	UG/L	145	
524.2 TVOC	7/5/2000	7.95	--	--	UG/L	145	
Chloroform	7/5/2000	0.55	0.5	--	UG/L	145	
1,1,1-Trichloroethane	1/9/2001	18.5	0.5	--	UG/L	145	
1,1-Dichloroethylene	1/9/2001	8.7	0.5	--	UG/L	145	
524.2 TVOC	1/9/2001	27.84	--	--	UG/L	145	
Chloroform	1/9/2001	0.64	0.5	--	UG/L	145	
1,1,1-Trichloroethane	7/2/2001	9.3	0.5	--	UG/L	145	
1,1-Dichloroethane	7/2/2001	0.35	0.5	--	UG/L	145	J
1,1-Dichloroethylene	7/2/2001	4.4	0.5	--	UG/L	145	
524.2 TVOC	7/2/2001	16	--	--	UG/L	145	
Chloroform	7/2/2001	0.54	0.5	--	UG/L	145	
Naphthalene	7/2/2001	1.1	0.5	--	UG/L	145	B
Toluene	7/2/2001	0.31	0.5	--	UG/L	145	J
1,1,1-Trichloroethane	10/8/2001	8.2	0.5	--	UG/L	145	
1,1-Dichloroethane	10/8/2001	0.27	0.5	--	UG/L	145	J
1,1-Dichloroethylene	10/8/2001	4.1	0.5	--	UG/L	145	
524.2 TVOC	10/8/2001	13.02	--	--	UG/L	145	
Chloroform	10/8/2001	0.45	0.5	--	UG/L	145	J
Tritium	1/14/2002	487	1150	678	PCI/L	145	DL
1,1,1-Trichloroethane	10/10/2002	24.5	0.5	--	UG/L	145	
1,1-Dichloroethane	10/10/2002	1.7	0.5	--	UG/L	145	
1,1-Dichloroethylene	10/10/2002	13.1	0.5	--	UG/L	145	
524.2 TVOC	10/10/2002	40.85	--	--	UG/L	145	
Chloroform	10/10/2002	0.57	0.5	--	UG/L	145	
Trichlorofluoromethane	10/10/2002	0.98	0.5	--	UG/L	145	
Tritium	10/10/2002	908	400	269	PCI/L	145	J
Tritium	4/24/2003	750	276	233	PCI/L	145	
1,1,1-Trichloroethane	10/27/2003	7	0.5	--	UG/L	145	
1,1-Dichloroethane	10/27/2003	0.96	0.5	--	UG/L	145	
1,1-Dichloroethylene	10/27/2003	3.7	0.5	--	UG/L	145	
524.2 TVOC	10/27/2003	12.46	--	--	UG/L	145	
Chloroform	10/27/2003	0.8	0.5	--	UG/L	145	
Tritium	1/29/2004	680	250	250	PCI/L	145	

Tritium	4/1/2004	370	310	220	PCI/L	175	J
Tritium	7/7/2004	390	340	230	PCI/L	145	J
1,1,1-Trichloroethane	10/6/2004	19	0.5	--	UG/L	145	
1,1-Dichloroethane	10/6/2004	2.7	0.5	--	UG/L	145	
1,1-Dichloroethylene	10/6/2004	10	0.5	--	UG/L	145	
524.2 TVOC	10/6/2004	34.28	--	--	UG/L	145	
Chloroform	10/6/2004	0.84	0.5	--	UG/L	145	
Methylene chloride	10/6/2004	0.68	0.5	--	UG/L	145	
Trichloroethylene	10/6/2004	0.5	0.5	--	UG/L	145	
Trichlorofluoromethane	10/6/2004	0.56	0.5	--	UG/L	145	
Tritium	10/6/2004	380	300	210	PCI/L	145	J
Tritium	1/5/2005	340	260	190	PCI/L	145	J
Tritium	4/1/2005	510	180	180	PCI/L	145	
1,1,1-Trichloroethane	10/7/2005	8.4	0.5	--	UG/L	140	
1,1-Dichloroethane	10/7/2005	1.1	0.5	--	UG/L	140	
1,1-Dichloroethylene	10/7/2005	3.3	0.5	--	UG/L	140	
524.2 TVOC	10/7/2005	13.99	--	--	UG/L	140	
Chloroform	10/7/2005	0.79	0.5	--	UG/L	140	
Trichloroethylene	10/7/2005	0.4	0.5	--	UG/L	140	J
Tritium	1/13/2006	380	340	230	PCI/L	145	J

Site ID: 085-171

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
1,1,1-Trichloroethane	1/24/2000	21.8	0.5	--	UG/L	135	
1,1-Dichloroethane	1/24/2000	1	0.5	--	UG/L	135	
1,1-Dichloroethylene	1/24/2000	9.7	0.5	--	UG/L	135	
1,2-Dichloroethane	1/24/2000	0.11	0.5	--	UG/L	135	J
524.2 TVOC	1/24/2000	35.892	--	--	UG/L	135	
Chloroform	1/24/2000	0.36	0.5	--	UG/L	135	J
m/p xylene	1/24/2000	0.032	0.5	--	UG/L	135	J
Methylene chloride	1/24/2000	0.49	0.5	--	UG/L	135	JB
Toluene	1/24/2000	0.08	0.5	--	UG/L	135	JB
Trichloroethylene	1/24/2000	0.22	0.5	--	UG/L	135	J
Trichlorofluoromethane	1/24/2000	2.1	0.5	--	UG/L	135	
1,1,1-Trichloroethane	7/12/2000	19.8	0.5	--	UG/L	130	
1,1-Dichloroethane	7/12/2000	1.6	0.5	--	UG/L	130	
1,1-Dichloroethylene	7/12/2000	7.6	0.5	--	UG/L	130	
524.2 TVOC	7/12/2000	33.99	--	--	UG/L	130	
Chloroform	7/12/2000	0.84	0.5	--	UG/L	130	
Methylene chloride	7/12/2000	0.81	0.5	--	UG/L	130	B
Toluene	7/12/2000	0.38	0.5	--	UG/L	130	J
Trichloroethylene	7/12/2000	0.76	0.5	--	UG/L	130	
Trichlorofluoromethane	7/12/2000	2.2	0.5	--	UG/L	130	
Tritium	7/12/2000	714	412	267	PCI/L	130	J
Tritium	10/19/2000	1230	470	320	PCI/L	130	
1,1,1-Trichloroethane	2/13/2001	6	0.5	--	UG/L	130	
1,1-Dichloroethane	2/13/2001	0.41	0.5	--	UG/L	130	J
1,1-Dichloroethylene	2/13/2001	1.9	0.5	--	UG/L	130	
524.2 TVOC	2/13/2001	9.43	--	--	UG/L	130	
Chloroform	2/13/2001	0.82	0.5	--	UG/L	130	
Trichloroethylene	2/13/2001	0.3	0.5	--	UG/L	130	J
Tritium	2/13/2001	845	320	213	PCI/L	130	J

1,1,1-Trichloroethane	7/19/2001	10.5	0.5	--	UG/L	130	
1,1-Dichloroethane	7/19/2001	0.93	0.5	--	UG/L	130	
1,1-Dichloroethylene	7/19/2001	4.3	0.5	--	UG/L	130	
524.2 TVOC	7/19/2001	17.09	--	--	UG/L	130	
Chloroform	7/19/2001	1	0.5	--	UG/L	130	
Trichloroethylene	7/19/2001	0.36	0.5	--	UG/L	130	J
Tritium	7/19/2001	469	430	268	PCI/L	130	J-N2
1,1,1-Trichloroethane	10/15/2001	13.9	0.5	--	UG/L	130	
1,1-Dichloroethane	10/15/2001	0.8	0.5	--	UG/L	130	
1,1-Dichloroethylene	10/15/2001	5.3	0.5	--	UG/L	130	
524.2 TVOC	10/15/2001	21.48	--	--	UG/L	130	
Chloroform	10/15/2001	0.88	0.5	--	UG/L	130	
Methyl chloride	10/15/2001	0.27	0.5	--	UG/L	130	J
Trichloroethylene	10/15/2001	0.33	0.5	--	UG/L	130	J
1,1,1-Trichloroethane	10/18/2002	16.4	0.5	--	UG/L	130	
1,1-Dichloroethane	10/18/2002	1	0.5	--	UG/L	130	
1,1-Dichloroethylene	10/18/2002	5.1	0.5	--	UG/L	130	
524.2 TVOC	10/18/2002	24.04	--	--	UG/L	130	
Chloroform	10/18/2002	0.96	0.5	--	UG/L	130	
Methylene chloride	10/18/2002	0.29	0.5	--	UG/L	130	J
Trichloroethylene	10/18/2002	0.29	0.5	--	UG/L	130	J
Tritium	8/6/2003	321	273	180	PCI/L	130	
1,1,1-Trichloroethane	10/30/2003	4.4	0.5	--	UG/L	130	J
1,1-Dichloroethane	10/30/2003	0.45	0.5	--	UG/L	130	J
1,1-Dichloroethylene	10/30/2003	1.6	0.5	--	UG/L	130	J
524.2 TVOC	10/30/2003	7.67	--	--	UG/L	130	
Chloroform	10/30/2003	0.77	0.5	--	UG/L	130	J
Methyl tert-butyl ether	10/30/2003	0.45	0.5	--	UG/L	130	J
Tritium	2/10/2004	350	220	180	PCI/L	130	J
1,1,1-Trichloroethane	4/11/2005	2.7	0.5	--	UG/L	130	
1,1-Dichloroethane	4/11/2005	0.53	0.5	--	UG/L	130	
1,1-Dichloroethylene	4/11/2005	1.3	0.5	--	UG/L	130	
524.2 TVOC	4/11/2005	6.01	--	--	UG/L	130	
Chloroform	4/11/2005	1.2	0.5	--	UG/L	130	
Toluene	4/11/2005	0.12	0.5	--	UG/L	130	J
Trichloroethylene	4/11/2005	0.16	0.5	--	UG/L	130	J
1,1,1-Trichloroethane	12/22/2005	2.1	0.5	--	UG/L	130	
1,1-Dichloroethane	12/22/2005	0.49	0.5	--	UG/L	130	J
1,1-Dichloroethylene	12/22/2005	1	0.5	--	UG/L	130	
524.2 TVOC	12/22/2005	4.18	--	--	UG/L	130	
Chloroform	12/22/2005	0.42	0.5	--	UG/L	130	J
Trichloroethylene	12/22/2005	0.17	0.5	--	UG/L	130	J
Tritium	12/22/2005	360	360	230	PCI/L	130	J
Tritium	1/24/2006	550	280	220	PCI/L	130	
Tritium	4/14/2006	460	350	230	PCI/L	130	J
Tritium	7/11/2006	550	390	270	PCI/L	130	

Site ID: 086-05

Chemical Name	Sample Date	Value	Det. Limit	Error	Units	Depth	Qual.
524.2 TVOC	2/11/2000	0.54	--	--	UG/L	85	
Chloroform	2/11/2000	0.54	0.5	--	UG/L	85	
524.2 TVOC	5/25/2000	0.63	--	--	UG/L	85	

Chloroform	5/25/2000	0.63	0.5	–	UG/L	85	
524.2 TVOC	8/31/2000	0.84	--	--	UG/L	85	
Chloroform	8/31/2000	0.84	0.5	--	UG/L	85	
Vanadium-48	8/31/2000	-4.3	10.4	6.36	PCI/L	85	DL
524.2 TVOC	11/30/2000	0.84	--	--	UG/L	85	
Chloroform	11/30/2000	0.84	0.5	--	UG/L	85	
524.2 TVOC	3/5/2001	0.44	–	–	UG/L	85	
Chloroform	3/5/2001	0.44	0.5	--	UG/L	85	J
524.2 TVOC	5/25/2001	0.75	--	--	UG/L	85	
Chloroform	5/25/2001	0.48	0.5	--	UG/L	85	J
Methylene chloride	5/25/2001	0.27	0.5	–	UG/L	85	J
524.2 TVOC	8/20/2001	0.4	--	--	UG/L	85	
Chloroform	8/20/2001	0.4	0.5	--	UG/L	85	J
524.2 TVOC	10/8/2001	0.33	–	--	UG/L	85	
Chloroform	10/8/2001	0.33	0.5	–	UG/L	85	J
524.2 TVOC	6/28/2002	0	--	–	UG/L	85	
524.2 TVOC	7/18/2003	0.27	--	--	UG/L	85	
Chloroform	7/18/2003	0.27	0.5	--	UG/L	85	J
524.2 TVOC	9/1/2004	0.29	–	–	UG/L	85	
Chloroform	9/1/2004	0.29	0.5	--	UG/L	85	J
Gross Alpha	9/1/2004	1.36	1.2	0.86	PCI/L	85	J
Gross Beta	9/1/2004	2.58	1.2	0.91	PCI/L	85	J
524.2 TVOC	8/29/2005	0.43	--	--	UG/L	85	
Chloroform	8/29/2005	0.43	0.5	–	UG/L	85	J

BROOKHAVEN NATIONAL LABORATORY

2009
Site Environmental Report

GROUNDWATER STATUS REPORT

VOLUME II

2009
SITE ENVIRONMENTAL REPORT
VOLUME II
GROUNDWATER STATUS REPORT

June 14, 2010

Environmental Protection Division
Groundwater Protection Group

Brookhaven National Laboratory
Operated by
Brookhaven Science Associates
Upton, NY 11973

Under Contract with the United States Department of Energy
Contract No. DE-AC02-98CH10886

Report Contributors

From the initial collection of samples to the final reproduction, the *2009 BNL Groundwater Status Report* required the expertise and cooperation of many people and organizations to complete. The contributions of the following individuals are gratefully acknowledged:

Environmental Protection Division
John Burke
William Dorsch
Brian Foley
George Goode
Robert Howe
Richard Lagattolla
Chris Ogeka
Robert Lee
Doug Paquette
Vincent Racaniello
Andrew Rohkohl
Frank Tramontano
Susan Young

Facility and Operations Directorate
Eric Kramer

J.R. Holzmacher P.E., LLC
Amanda DiazGranados
Diana Holzmacher
Lucas Robak
Kyle Sarich
Anthony Zalak
Patricia Zalak

R&C Formations, LTD.
Robert Casson
Philip Hoffken Jr.
Melissa Yost
Arthur John Scheff
Dan Melo

D. B. Bennett Consulting Engineer
Drew Bennett

TERRA Editing, Inc.
Joanne Yeary

P. W. Grosser Consulting
Adrian Steinhauff

This page intentionally left blank.

Contents

List of Appendices

List of Figures

This page intentionally left blank.

List of Tables

Acronyms and Abbreviations

These acronyms and abbreviations reflect the typical manner in which terms are used in Volume II of this document, and may not apply to all situations.

AGS	Alternating Gradient Synchrotron
AOC	Area of Concern
AS/SVE	Air Sparge/Soil Vapor Extraction
AWQS	Ambient Water Quality Standards
BGD	Below Ground Ducts
BGRR	Brookhaven Graphite Research Reactor
BLIP	Brookhaven Linac Isotope Producer
bls	below land surface
BMRR	Brookhaven Medical Research Reactor
BNL	Brookhaven National Laboratory
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cfm	cubic feet per minute
CFR	Code of Federal Regulations
COC	Chain of Custody
Cr	chromium
Cr(VI)	hexavalent chromium
CRDL	Contract Required Detection Limit
CSF	Central Steam Facility
CY	calendar year
DCA	1,1-dichloroethane
DCE	1,1-dichloroethylene
DCG	Derived Concentration Guide
DNAPL	dense non-aqueous-phase liquid
DOE	United States Department of Energy
DQO	Data Quality Objective
DTW	Depth to Water
DWS	Drinking Water Standards
EDB	ethylene dibromide
EDD	Electronic Data Deliverable
EE/CA	Engineering Evaluation/Cost Analysis
EIMS	Environmental Information Management System
EM	Environmental Management
EMS	Environmental Management System
EPA	United States Environmental Protection Agency
EPD	Environmental Protection Division
ER	Emissions Rate
ERP	Emissions Rate Potential
ES	Environmental Surveillance
ESD	Explanation of Significant Differences
EW	extraction well
FFA	Federal Facility Agreement
ft	feet
ft msl	feet relative to mean sea level
GAC	granular activated carbon
gal/hr	gallons per hour
gpm	gallons per minute
HFBR	High Flux Beam Reactor
HWMF	Hazardous Waste Management Facility
IAG	Inter Agency Agreement
ID	identification
lb/gal	pounds per gallon
lb/hr	pounds per hour
lbs	pounds
LIE	Long Island Expressway
Linac	Linear Accelerator
LIPA	Long Island Power Authority
LTRA	Long Term Response Actions
mCi	milliCuries
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Activity
MDL	Minimum Detection Limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MGD	millions of gallons per day
MNA	Monitored Natural Attenuation
MPF	Major Petroleum Facility
mrem/yr	millirems per year
MS/MSD	Matrix Spike/Matrix Spike Duplicate
msl	mean sea level
MTBE	methyl tertiary-butyl ether
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NSE	North Street East
NSLS-II	National Synchrotron Light Source II
NSRL	NASA Space Radiation Laboratory
NYCRR	New York Code of Rules and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health

O&M	Operation and Maintenance
OU	Operable Unit
PCBs	polychlorinated biphenyls
PCE	tetrachloroethylene
pCi/L	picoCuries per liter
PFS	Pile Fan sump
PLC	programmable logic controller
QA/QC	Quality Assurance and Quality Control
RA V	Removal Action V
RCRA	Resource Conservation and Recovery Act
RHIC	Relativistic Heavy Ion Collider
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPD	Relative Percent Difference
RTW	Recirculating Treatment Well
RW	remediation well
SBMS	Standards Based Management System
SCDHS	Suffolk County Department of Health Services
SCWA	Suffolk County Water Authority
SDG	Sample Delivery Group
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
SPCC	Spill Prevention Control and Countermeasures
SPDES	State Pollutant Discharge Elimination System
Sr-90	strontium-90
STP	Sewage Treatment Plant
SU	standard unit
SVOC	semivolatile organic compound
TCA	1,1,1-trichloroethane
TCE	trichloroethylene
TVOC	total volatile organic compound
USGS	United States Geological Survey
UST	underground storage tank
VOC	volatile organic compound
µg/L	micrograms per liter
WCF	Waste Concentration Facility
WLA	Waste Loading Area
WMF	Waste Management Facility

2009 BROOKHAVEN NATIONAL LABORATORY

GROUNDWATER STATUS REPORT

Executive Summary

The mission of the Laboratory's Groundwater Protection Program is to protect and restore the aquifer system at Brookhaven National Laboratory (BNL). Four key elements make up the program:

- **Pollution prevention** – preventing the potential pollution of groundwater at the source
- **Monitoring** – monitoring the effectiveness of pollution-prevention efforts, as well as progress in restoring contaminated groundwater
- **Restoration** – maintaining groundwater treatment systems and restoring groundwater quality that BNL has impacted
- **Communication** – communicating the findings and the results of the program to regulators and other stakeholders

The *2009 BNL Groundwater Status Report* is a comprehensive summary of data collected during the calendar year, and an evaluation of Groundwater Protection Program performance. This is the thirteenth annual groundwater status report issued by BNL. This document examines the performance of the program on a project-by-project basis.

How to Use This Document. This detailed technical document includes summaries of laboratory data, as well as data interpretations. Area summary level review of this information is presented as Chapter 7 of Volume I of the *Site Environmental Report*. Groundwater restoration is performed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) by the Groundwater Protection Group, and includes measuring and monitoring of groundwater remediation performance, and efforts in achieving cleanup goals. Facility Monitoring refers to the monitoring of groundwater quality at active research and support facilities, primarily in response to Department of Energy (DOE) Order 450.1A, Environmental Protection. Data are presented in five key areas:

- Improvements to the understanding of the hydrogeologic environment beneath BNL and surrounding areas
- Identification of any new impacts on groundwater quality due to BNL's active operations
- Progress in cleaning up the groundwater contamination
- Performance of individual groundwater remediation systems
- Recommended changes to the groundwater protection program

This document satisfies BNL's requirement to report groundwater data under the Federal Facility Agreement (FFA), and partially fulfills the commitment of BNL's Groundwater Protection Program to communicate the findings and progress of the program to regulators and stakeholders.

Section 1 summarizes the regulatory requirements of the data collection work in 2009, the site's groundwater classification, and the objectives of the groundwater monitoring efforts. **Section 2** discusses improvements to our understanding of the hydrogeologic environment at BNL and its surrounding area. It also summarizes the dynamics of the groundwater flow system in 2009. **Section 3** summarizes the groundwater cleanup data, progress towards achieving the site's cleanup goals, and recommended modifications to the remediation systems or monitoring programs.

Section 4 summarizes the facility monitoring data used to verify that operational and engineering controls are preventing further contamination from the site's active experimental and support facilities. The recommended changes to the Groundwater Protection Program are summarized in **Section 5**.

HYDROGEOLOGIC DATA

The following were important hydrogeologic findings in 2009:

- The desired flow conditions continued to be maintained in the central portion of the site during 2009, with 75 percent of the supply well water pumpage being derived from the western supply-well field. No shifting of contaminant plumes outside of the established monitoring networks was observed on site in 2009.
- Total annual precipitation in 2009 was 54.2 inches, which is above the yearly average of 48 inches. Nine of the past 12 years have featured above-normal average precipitation at BNL.

GROUNDWATER RESTORATION (CERCLA)

Table E-1 summarizes the status and progress of groundwater cleanup at BNL under the provisions of CERCLA. During 2009, 11 volatile organic compound (VOC) groundwater remediation systems were in operation, along with two strontium-90 (Sr-90) treatment systems, and a tritium pump and recharge system. In 2009, 229 pounds of VOCs were removed from the aquifers by the treatment systems. To date, 6,363 pounds of VOCs have been removed from the aquifer. The Operable Unit (OU) III Chemical/Animal Holes Sr-90 System removed 0.46 milli Curies (mCi) of Sr-90 from the Upper Glacial aquifer in 2009, for a total of 3.79 mCi since operations began in 2003. The OU III Brookhaven Graphite Research Reactor (BGRR) Sr-90 System removed 1.4 mCi of Sr-90 during the year, for a total of 17.5 mCi since operations began in 2005.

While groundwater remediation is expected to be a long-term process, there are noticeable improvements in groundwater quality for most of the plumes. The OU IV Air Sparging/Soil Vapor Extraction (AS/SVE) system was decommissioned in 2003, and the OU III Carbon Tetrachloride System is being decommissioned in 2010. A number of individual extraction wells have been placed on standby because of remediation progress. A petition for shutdown of Industrial Park East System was approved in 2009. The submittal of a petition to shutdown the North Street East System is anticipated for 2010. The OU V/STP VOC plume attenuated to below Drinking Water Standards (DWS) in 2009. Groundwater remediation activities are expected to continue until the cleanup objectives for the plumes have been met. The specific goals are as follows:

- Achieve maximum contaminant levels (MCLs) for VOCs in the Upper Glacial aquifer by 2030
- Achieve MCLs for VOCs in the Magothy aquifer by 2065
- Achieve the MCL of 8 pico Curies per liter (pCi/L) for Sr-90 at the BGRR in the Upper Glacial aquifer by 2070
- Achieve the MCL of 8 pCi/L for Sr-90 at the Chemical/Animal Holes in the Upper Glacial aquifer by 2040

The cleanup objectives will be met by a combination of active treatment and natural attenuation. The comprehensive groundwater monitoring program will measure the remediation progress.

The locations and extent of the primary VOC and radionuclide plumes at BNL, as of December

2009, are summarized on **Figures E-1** and **E-2**, respectively. Significant items of interest during 2009 were the following:

- A total of 698 monitoring wells were sampled as part of the CERCLA Groundwater Monitoring Program, comprising a total of 1,617 groundwater samples. In 2009, 70 temporary wells were also installed under the CERCLA program. BNL continued to make significant progress in characterizing and restoring groundwater quality at the site.
- 1.7 billion gallons of groundwater were treated, and 229 pounds of VOCs and 1.9 mCi of Sr-90 were removed from the aquifer. (**Table E-1**).

Table E-1.
BNL Groundwater Remediation System Treatment Summary for 1997 – 2009.

	1997 – 2008		2009	
VOCs Remediation (start date)	Water Treated (gallons)	VOCs Removed (pounds)(c)	Water Treated (gallons)	VOCs Removed (pounds)(c)
OU III South Boundary (June 1997)	3,319,952,850	2,630	201,000,000	85
OU III Industrial Park (Sept. 1999)	1,492,478,330	1,033	148,000,000	12
OU III W. South Boundary (Sept. 2002)	667,647,000	54	115,300,000	12
OU III Carbon Tetrachloride (Oct. 1999)	153,538,075	349	0	0
OU I South Boundary (Dec. 1996)	3,442,314,000	347	172,000,000	6.4
OU III HFBR Tritium Plume (May 1997) (a)	334,987,000	180	103,000,000	0
OU IV AS/SVE (Nov. 1997) (b)	0	35	0	0
OU III Building 96 (Feb. 2001)	172,297,416	98	50,000,000	9
OU III Middle Road (Oct. 2001)	1,417,411,550	799	177,500,000	63
OU III Industrial Park East (May 2004)	320,172,000	35	37,000,000	3
OU III North Street (June 2004)	869,122,000	290	135,000,000	10
OU III North Street East (June 2004)	492,976,000	24	74,000,000	6
OU III LIPA/Airport (June 2004)	1,072,887,000	260	266,000,000	23
OU VI EDB (August 2004)	624,711,000	NA(d)	164,000,000	NA (d)
Totals	14,380,485,221	6,134	1,642,800,000	229

	2003 – 2008		2009	
Sr-90 Remediation (start date)	Water Treated (gallons)	Sr-90 Removed (mCi)	Water Treated (gallons)	Sr-90 Removed (mCi)
OU III Chemical Holes (Feb 2003)	18,404,826	3.33	6,200,000	0.46
OU III BGRR (June 2005)	30,951,000	16.1	8,500,000	1.4
Totals	49,355,826	19.4	14,700,000	1.86

Notes:

(a) System was placed in standby mode on Sept. 29, 2000, but restarted November 2007.

(b) Air Sparging/Soil Vapor Extraction (AS/SVE) system performance measured by pounds of volatile organic compounds (VOCs) removed. System was dismantled in December 2003.

(c) Values rounded to the nearest whole number.

(d) Ethylene dibromide (EDB) has been detected in the system influent at trace levels well below the standard since operations began. Therefore, no removal of VOCs is reported.

NA – Not applicable

mCi – milli Curies

- The BGRR/Waste Concentration Facility (WCF) Sr-90 Treatment System will be modified in 2010 to incorporate four additional extraction wells to address the downgradient high concentration area. Groundwater monitoring and characterization over the five years that this system has been in operation indicates that source area Sr-90 concentrations in the vicinity of both the WCF and the Building 701 areas have not shown marked decreases. There may be a continuing source of Sr-90 in these areas. Sr-90 from both of these source areas is presently being captured and treated by source area extraction wells, thereby preventing any plume growth.
- The Operable Unit III Explanation of Significance for the Building 96 Groundwater Treatment System was signed by the regulators in September 2009 and calls for the removal of the PCE contaminated source area soils. This work is planned for 2010.
- There have been significant improvements to the OU I South Boundary VOC plume over the previous 14 years. However, based on the slower than expected migration rate of a small area of elevated VOCs, located in a low permeability unit approximately 500 feet north of the south boundary, it does not appear that the ROD cleanup goals would be met if the extraction wells are shutdown in 2011 as originally planned. BNL will evaluate extending the operational duration of the existing extraction wells to ensure that the cleanup goal is attained. Based on the peak Sr-90 concentrations characterized to date, groundwater modeling shows this area of Sr-90 reaching the site boundary at concentrations below the DWS in approximately 12 years.
- The High Flux Beam Reactor (HFBR) Tritium Pump and Recharge system was operational during 2009 with extraction well EW-16 capturing the downgradient high concentration tritium slug. The system is expected to remain operational for several years until this small area has been completely captured, and tritium concentrations in the area decrease below the 20,000 pCi/L DWS. Tritium concentrations immediately downgradient of the HFBR remained below the DWS during 2009, providing evidence that the inventory of tritium remaining in the unsaturated zone beneath the building continues to diminish.
- Temporary well characterization of the Building 650 and Sump Outfall Sr-90 plume in 2009 showed the area of highest concentrations approximately 500 feet north of Brookhaven Avenue. The new data will be used to update the groundwater model and determine when the plume is expected to attenuate to below DWS.
- Elevated concentrations of Dichlorodifluoromethane (Freon-12) were detected in a permanent well in the OU III Western South Boundary area during 2009 sampling events. This well had been installed following a detection of Freon-12 during groundwater characterization in 2008. The *2008 BNL Groundwater Status Report* recommended evaluating this contamination following a year of well monitoring. Additional characterization is recommended for 2010 to determine the extent of this contamination.

Progress of the groundwater restoration program is summarized on **Table E-2**.

INSTITUTIONAL CONTROLS

Institutional controls are in place at BNL to ensure effectiveness of all groundwater remedies. During 2009, the institutional controls continued to be effective in protecting human health and the environment. In accordance with the *BNL Land Use Controls Management Plan* (2007a), the following institutional controls continued to be implemented for the groundwater remediation program.

- Groundwater monitoring, including BNL potable supply systems and Suffolk County Department of Health Services (SCDHS) monitoring of Suffolk County Water Authority (SCWA) well fields closest to BNL
- Conduct five-year reviews (next scheduled for 2010), as required by CERCLA, until cleanup goals are met and to determine the effectiveness of the groundwater monitoring program
- Implement controls on the installation of new supply wells and recharge basins on BNL property
- Provide public water service in plume areas south and east of BNL
- Place prohibitions on the installation of new potable water-supply wells where public water service exists (Suffolk County Sanitary Code Article 4)
- Implement property access agreements for treatment systems off the BNL property

An annual update on Institutional Controls summarizing noteworthy issues, changes, breaches, etc. was submitted to the regulatory agencies in February 2009 and approved in June 2009.

FACILITY MONITORING

During 2009, the Facility Monitoring Program monitored groundwater quality at 10 research and support facilities. Groundwater samples were collected from 108 wells, for a total of approximately 183 individual samples. BNL also installed nine temporary wells to track the downgradient segment of the g-2 Tritium Plume. Although no new impacts to groundwater quality were discovered during 2009, groundwater quality continues to be impacted at two facilities: continued periodic high levels of tritium at the g-2 Tritium Source Area, and continued VOCs at the On-Site Service Station.

Highlights for the Facility Monitoring Program are as follow:

- Tritium continues to be detected in the g-2 Tritium Source Area monitoring wells at concentrations above the 20,000 pCi/L DWS. A short-term spike in tritium levels was observed in October 2009, with a tritium concentration of 138,000 pCi/L. Tritium concentrations in the source area wells dropped to less than 63,000 pCi/L by January 2010. Although the engineered stormwater controls are effectively protecting the activated soil shielding at the source area, monitoring data indicate that the continued release of tritium appears to be related to the flushing of residual tritium from the deep vadose zone following significant natural periodic fluctuations in the local water table.
- Monitoring of the downgradient areas of the g-2 tritium plume was accomplished using a combination of permanent and temporary wells. The highest tritium concentration in the downgradient segment of the plume was 92,200 pCi/L. This concentration was observed in a temporary well installed approximately 400 feet south of the HFBR facility, along Temple Place road. The southern extent of the plume was tracked to the north side of the National Synchrotron Light Source (NSLS), where a maximum tritium concentration of 78,600 pCi/L was detected. As a result of natural radioactive decay and dispersion in the aquifer, the tritium plume is breaking up into discrete segments.
- At the Brookhaven Linac Isotope Producer (BLIP) facility, tritium concentrations in groundwater have been less than the 20,000 pCi/L DWS since April 2006. The maximum tritium concentration during 2009 was 4,240 pCi/L. These results indicate that the engineered stormwater controls are effectively protecting the activated soil shielding, and that the amount of residual tritium in the deep vadose zone is diminishing.

PROPOSED CHANGES TO THE GROUNDWATER PROTECTION PROGRAM

The data summarized in this report are the basis for several significant operational and groundwater monitoring changes to the groundwater protection program. A summary of the changes follows (specific details of which are provided in **Section 5**).

- **OU I South Boundary System** – Install a permanent well approximately 75 feet north of EW-1 and EW-2. Based on data from the new monitoring well, evaluate the alternatives of either increasing the operational duration of EW-1 and EW-2 or adding a third extraction well in order to achieve the cleanup goals. Install two new sentinel wells approximately 200 feet south of the Princeton Avenue firebreak road to monitor for the leading edge of the Sr-90 plume.
- **Building 96 System** – Install temporary wells upgradient of recirculation wells RTW-2, RTW-3, and RTW-4. If VOCs in these wells and the recirculation wells are below 50 μg/L, then wells RTW-2, RTW-3, and RTW-4 will be placed in standby mode. Maintain a monthly sampling frequency of the influent and effluent for each well. Based on the results of the data from the three temporary wells installed along Weaver Drive, a permanent well will be installed.
- **Middle Road System** – Install one temporary well approximately 300 feet west of monitoring well 104-36 and based upon the results of this temporary well install a monitoring well to monitor the progression of higher upgradient concentrations of TVOCs to the treatment system. Install a monitoring well centered on the high concentrations identified in the recent temporary well near well RW-1.
- **OU III South Boundary System -** Install a temporary well near well EW-4 to evaluate the depth of the high concentrations of VOCs are near this extraction well. This well should be installed at the Upper Glacial - Magothy Brown Clay interface (approximately -160 feet below MSL). This will help evaluate whether the VOCs detected in well 121-43 are caught in the stagnation zone or may be passing under well EW-4.
- **OU III Western South Boundary System** – Due to indications of increased TVOC concentrations in plume core monitoring wells in close proximity to extraction well WSB-1, installation of a permanent monitoring well should be implemented during 2010. The well should be located approximately 700 feet north of WSB-1. Install two temporary wells in the vicinity of Princeton Avenue to better define the northerly portion of the core area of the plume where higher concentrations of Freon-12 have been observed.
- **Industrial Park System -** It is recommended that well UVB-2 be placed in standby as TVOC concentrations have dropped to below 5 μg/L and all of the monitoring wells in the vicinity are below 50 μg/L. A temporary well should be installed and sampled between wells UVB-3 and UVB-4 to evaluate the VOC concentrations in this area. If concentrations in well 000-262 drop below the 50 μg/L TVOC capture goal a petition to shutdown this system may be submitted to the regulators.
- **Industrial Park East System** – Install one additional downgradient monitoring well in the vicinity of well 000-107 on Stratler Drive to monitor Magothy contamination identified in well 000-494.
- **North Street System –** It is recommended to begin pulse-pumping extraction well NS-1, one month on and one month off during 2010 due to TVOC concentrations below the 50 μg/L capture goal in upgradient monitoring wells. If there is any rebounding of higher TVOC concentrations the extraction well will be placed back in full-time operation.

- **North Street East System –** Extraction well NSE-1 will remain in full-time operation. Extraction well NSE-2 will be shut off, and placed in a stand-by mode. If concentrations above the capture goal of 50 µg/L TVOCs are observed in either the core monitoring wells or the extraction wells, NSE-2 will be put back into full-time operation. Install a temporary well northwest (upgradient) of monitoring well 000-477 to determine the vertical extent of TVOC concentrations.
- **LIPA/Airport System** - Place LIPA Well EW-2 in standby as this well was below New York State Ambient Water Quality Standard (NYS AWQS) throughout 2009.
- **BGRR/WCF Sr-90 System –** Install four additional extraction wells during 2010 to address the Sr-90 hot spots identified in the WCF plume. Install several temporary wells to characterize Sr-90 concentrations in the WCF source area. Install sentinel wells on the south side of Brookhaven Avenue to monitor the leading edge of the BGRR Sr-90 plume. Characterize the width of the plume at the well 075-664 location and install a new permanent monitoring well for the BGRR Sr-90 plume adjacent to monitoring well 075-664 screened at a shallower depth. Install temporary wells at Brookhaven Avenue to characterize the leading edge of the Pile-Fan Sump plume.
- **Chemical/Animal Holes Sr-90 System –** Complete temporary well investigations in the vicinity of monitoring well 106-48 to determine the current plume perimeter.
- **HFBR Tritium System** - Increase the sampling frequency for monitoring wells 075-42, 075-43, 075-44, and 075-45 to monthly as a result of the historical high water-table elevations during 2010 to monitor for any corresponding source area tritium releases. Continue monitoring for six months and then re-evaluate based on water-table conditions and observed tritium data. The pump and recharge well(s) will be operated until the tritium concentrations from Weaver Drive to EW-16 drop below 20,000 pCi/L. The estimated operational duration of 2 to 4 years (2011 to 2013) is based on the length of the high concentration area slug and the time it would take to be completely captured by EW-16.
- **Building 650 Sump Outfall Sr-90 and g-2 Plumes** – Update the groundwater model with the 2009/2010 characterization data and run a new simulation to predict the expected time frame for achieving drinking water standards by natural attenuation of the plume. Install two monitoring wells in the downgradient plume core area and a sentinel well near the leading edge of the plume.
- **CERCLA Groundwater Monitoring Program** – Adjust the sampling frequencies for a total of 64 monitoring wells as described in the individual program recommendations.

Table E-2.
Groundwater Restoration Progress.

Project	Target	Mode	Treatment Type	Expected System Shutdown	Highlights
OU I					
OU I South Boundary (RA V)	VOCs	Operational	P&T with AS	2011-15	Higher VOC concentration area of plume migrating slower than expected.
Current Landfill	VOCs tritium	Long Term Monitoring & Maintenance	Landfill capping	NA	Groundwater continues slow improvement. VOCs and tritium stable or slightly decreasing.
Former Landfill	VOCs Sr-90 tritium	Long Term Monitoring & Maintenance	Landfill capping	NA	No longer a continuing source of contaminants to groundwater.
Former HWMF	Sr-90	Long Term Response Action	Monitoring	NA	Sr-90 data from 2009 characterization indicates concentrations will bebelow DWS before reaching site boundary.
OU III					
Chemical/Animal Holes	Sr-90	Operational (EW-1 pulse pumping)	P&T with ion exchange (IE)	2014	System performing as expected. Began characterization of Sr-90 in western perimeter well.
Carbon Tetrachloride source control	VOCs (carbon tetra-chloride)	Standby	P&T with carbon	2009 (Complete)	Petition for closure signed in 2009. System to be decommissioned in 2010.
Building 96 source control	VOCs	Operational	Recirculation wells with AS for 3 of 4 wells. RTW-1 is P&T with AS.	2016	System pumping and treating high concentrations of VOCs. Source area soil remediation scheduled for 2010.
South Boundary	VOCs	Operational (EW-6, EW-7, EW-8 and EW-12 on standby)	P&T with AS	2013	Continued decline in monitoring well VOC concentrations at the site boundary with the exception of one well in the vicinity of EW-4 and EW-5.
Middle Road	VOCs	Operational (RW-4, RW-5, and RW-6 on standby)	P&T with AS	2025	Extraction wells RW-1 and RW-2 continue to show moderate VOC levels. Eastern extraction wells showing low VOC concentrations.

continued

Project	Target	Mode	Treatment Type	Expected System Shutdown	Groundwater Quality Highlights
OU III (cont.)					
Western South Boundary	VOCs	Operational (Pulse)	P&T with AS	2019	Freon-12 detected during 2008 persisting in monitoring well. Additional characterization planned.
Industrial Park	VOCs	Operational (UVB-1 on standby)	In-well stripping	2012	VOC concentrations continued to decline. Place UVB-2 on standby.
Industrial Park East	VOCs	Standby	P&T with carbon	2009 (Complete)	Monitoring remaining low VOC concentrations.
North Street	VOCs	Operational	P&T with carbon	2012	Plume concentrations continue to decrease. Begin pulse pumping NS-1.
North Street East	VOCs	Operational (Pulse)	P&T with carbon	2010	Concentrations in plume core wells at very low levels in 2009. Prepare petition for shutdown.
Long Island Power Authority (LIPA) Right of Way/ Airport	VOCs	Operational	P&T and recirculation wells with carbon	2014 (LIPA) 2019 (Airport)	Airport wells continued pulse pumping in 2009. Place LIPA well EW-2 in standby.
HFBR Tritium	Tritium	Operational	Pump and recharge	2012	Leading edge of high concentration slug being captured by EW-16. Concentrations in source area wells remained below DWS throughout 2009.
BGRR/WCF	Sr-90	Operational	P&T with IE	2026	Continuing source areas observed at both the WCF and Building 701. System modification design in progress.
OU IV					
OU IV AS/SVE system	VOCs	Decommissioned	Air sparging/ soil vapor extraction	2003 (Complete)	VOC concentrations in monitoring wells remain low. System decommissioned in Dec. 2003.
Building 650 sump outfall	Sr-90	Long Term Response Action	Monitored Natural Attenuation (MNA)	NA	Plume characterized in 2009. Higher concentration area of plume ~500' north of Brookhaven Avenue.
OU V					
STP	VOCs, tritium	Long Term Response Action	MNA	NA	VOC plume has largely attenuated to below DWS.
OU VI					
Ethylene Dibromide (EDB)	EDB	Operational	P&T with carbon	2015	The EDB plume continues to migrate as predicted. The extraction wells are capturing the plume.

1.0 INTRODUCTION AND OBJECTIVES

The mission of Brookhaven National Laboratory's Groundwater Protection Program is to protect and restore the aquifer system at Brookhaven National Laboratory (BNL). The program is built on four key elements:

- Pollution prevention–preventing the potential pollution of groundwater at the source
- Restoration–restoring groundwater that BNL operations have impacted
- Monitoring–monitoring the effectiveness of pollution-prevention efforts, as well as progress in restoring the quality of affected groundwater
- Communication–communicating the findings and results of the program to regulators and stakeholders

The *BNL 2009 Groundwater Status Report* is a comprehensive summary of groundwater data collected in calendar year 2009 that provides an interpretation of information on the performance of the Groundwater Protection Program. This is the 13 annual groundwater status report issued by BNL. This document examines performance of the program on a project-by-project (facility-by-facility) basis, as well as comprehensively.

How To Use This Document. This document is a detailed technical report that includes analytical laboratory data, as well as data interpretations conducted by BNL's Groundwater Protection Group. This document can also be obtained through BNL's website. Data are presented in four key subject areas:

- Improvements to the understanding of the hydrogeologic environment and surrounding areas
- Identification of any new impacts to groundwater quality due to BNL's active operations
- Progress in cleaning contaminated groundwater
- Proposed changes to the groundwater protection program

This document satisfies BNL's requirement to report groundwater data under the Interagency Agreement and partially fulfills the commitment of the Groundwater Protection Program to communicate the program's findings and progress to regulators and stakeholders.

Section 1 discusses the regulatory requirements of the data collection work in 2009, the site's groundwater classification, and the objectives of groundwater monitoring. **Section 2** discusses the hydrogeologic environment at BNL and its surrounding area. It also summarizes the dynamics of the groundwater flow system in 2009. In **Section 3**, the groundwater cleanup data and progress towards achieving the site's cleanup goals are described. **Section 4** outlines the groundwater surveillance data used to verify that operational and engineered controls are preventing further contamination from BNL's active experimental and support facilities. **Section 5** is a summary of the proposed recommendations to the Groundwater Protection Program identified in **Sections 3 and 4**.

Appendices A and **B** include hydrogeologic data that support the discussions in **Section 2**. **Appendix C** contains the analytical results for each sample obtained under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) program. **Appendix D** contains analytical results for each sample obtained under the Facility Monitoring program. Due to the volume of these data, all of the report appendices are included on a CD-ROM, which significantly reduces the size of this report in printed format. The CD-ROM has a contents table with active links; by selecting the specific project and analytical suite, the user will be directed to the associated table of results. The groundwater results are arranged by specific monitoring project and analytical group: volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, general chemistry, pesticides/polychlorinated biphenyls (PCBs), and radionuclides. The data are organized further by well identification (ID) and the date of sample collection. Chemical/radionuclide concentrations, detection limits, and uncertainties are reported, along with a data verification, validation, and/or usability qualifier (if assigned), and/or a laboratory data qualifier. If a data verification/validation qualifier was not assigned, the laboratory data qualifier is shown. Results exceeding the corresponding groundwater standard or guidance criteria (see **Section 1.1.2**) are identified by bold text. Including the complete results enables the reader to analyze the data in detail. **Appendix E** contains information on sample collection, analysis, and Quality Assurance/Quality Control (QA/QC). **Appendix F** consists of data supporting the remediation system discussions in **Section 3**, and **Appendix G** is a compilation of data usability report forms. **Appendix H** contains the RW-2 Middle Road Pump Test Report, dated September 2009.

1.1 Groundwater Monitoring Program

1.1.1 Regulatory Requirements

Activities at BNL are driven by federal and state regulations as well as Department of Energy (DOE) Orders.

Comprehensive Environmental Response, Compensation and Liability Act

On December 21, 1989, BNL was included as a Superfund Site on the National Priorities List (NPL) of contaminated sites identified for priority cleanup. DOE, the United States Department of Environmental Protection (EPA), and the New York State Department of Environmental Conservation (NYSDEC) created a comprehensive Federal Facility Agreement (FFA) that integrated DOE's response obligations under CERCLA, the Resource Conservation and Recovery Act (RCRA), and New York State hazardous waste regulations. The FFA, also known as the interagency agreement, was finalized and signed by these parties in May 1992, and includes a requirement for groundwater monitoring (USEPA 1992).

New York State Regulations, Permits, and Licenses

The monitoring programs for the Current Landfill and Former Landfill are designed in accordance with post-closure Operation and Maintenance requirements specified in 6 NYCRR (New York Code of Rules and Regulations) Part 360, *Solid Waste Management Facilities*.

BNL's Major Petroleum Facility (MPF) is operated under NYSDEC Bulk Petroleum Storage License No. 01-1700. This license requires BNL to routinely monitor the groundwater. Together with approved engineering controls, the groundwater monitoring program verifies that storage operations for bulk fuel have not degraded the quality of the groundwater. The engineered controls and monitoring program for the MPF are described in the *BNL Spill Prevention, Control and Countermeasures Plan* (BNL 2001a).

BNL's Waste Management Facility (WMF) is a hazardous waste storage facility operated under NYSDEC RCRA Part B Permit No. 1-422-00032/00102-0. The permit requires groundwater monitoring as a secondary means of verifying the effectiveness of the facility's administrative and engineered controls.

DOE Orders

DOE Order 450.1, Section 5-D-14, *Responsibilities*, states that DOE facilities are required to "Conduct environmental monitoring, as appropriate, to support the site's ISMS [Integrated Safety Management System], to detect, characterize, and respond to releases from DOE activities; assess impacts; estimate dispersal patterns in the environment; characterize the pathways of exposure to members of the public; characterize the exposures and doses to individuals, and to the population; and to evaluate the potential impacts to the biota in the vicinity of the DOE activity" (DOE 2003).

1.1.2 Groundwater Quality and Classification

In Suffolk County, drinking water supplies are obtained exclusively from groundwater aquifers (e.g., the Upper Glacial aquifer, the Magothy aquifer, and, to a limited extent, the Lloyd aquifer). In 1978, EPA designated the Long Island aquifer system as a sole source aquifer pursuant to Section 1424(e) of the Safe Drinking Water Act (SDWA). Groundwater in the sole source aquifers underlying the BNL site is classified as "Class GA Fresh Groundwater" by the State of New York (6 NYCRR Parts 700–705); the best usage of Class GA groundwater is as a source of potable water. Accordingly, in establishing the goals for protecting and remediating groundwater, BNL followed federal Drinking Water Standards (DWS), New York State (NYS) DWS, and NYS Ambient Water Quality Standards (AWQS) for Class GA groundwater.

For drinking water supplies, the applicable federal maximum contaminant levels (MCLs) are set forth in 40 CFR (Code of Federal Regulations) 141 (for primary MCLs) and 40 CFR 143 (for secondary MCLs). In New York State, the SDWA requirements relating to the distribution and monitoring of public water supplies are promulgated under the NYS Sanitary Code (10 NYCRR Part 5), enforced by the Suffolk County Department of Health Services (SCDHS) as an agent for the New York State Department of Health (NYSDOH). These regulations apply to any water supply that has at least five service connections or that regularly serves at least 25 individuals. BNL supplies water to approximately 3,500 employees and visitors, and therefore must comply with these regulations. In addition, DOE Order 5400.5, *Radiation Protection of the Public and Environment* (DOE 1993), establishes Derived Concentration Guides (DCGs) for radionuclides not covered by existing federal or state regulations.

BNL evaluates the potential impact of radiological and nonradiological levels of contamination by comparing analytical results to NYS and DOE reference levels. Nonradiological data from groundwater samples collected from surveillance wells usually are compared to NYS AWQS (6 NYCRR Part 703.5). Radiological data are compared to the NYS AWQS for tritium, strontium-90 (Sr-90), gross beta; gross alpha, radium-226, and radium-228; and the 40 CFR 141/DOE DCGs for determining the 4 millirems per year (mrem/yr) dose for other beta- or gamma-emitting radionuclides.

Tables 1-1, 1-2, 1-3, and **1-4** show the regulatory and DOE "standards, criteria, and guidance" used for comparisons to BNL's groundwater data.

1.1.3 Monitoring Objectives

Groundwater monitoring is driven by regulatory requirements, DOE Orders, best management practice, and BNL's commitment to environmental stewardship. BNL monitors its groundwater resources for the following reasons:

Groundwater Resource Management

- To support initiatives in protecting, managing, and remediating groundwater by refining the conceptual hydrogeologic model of the site and maintaining a current assessment of the dynamic patterns of groundwater flow and water-table fluctuations.
- To determine the natural background concentrations for comparative purposes. The site's background wells provide information on the chemical composition of groundwater that has not been affected by BNL's activities. These data are a valuable reference for comparison with the groundwater quality data from affected areas. The network of wells also can warn of any contaminants originating from potential sources that may be located upgradient of the BNL site.
- To ensure that potable water supplies meet all regulatory requirements.

Groundwater Facility Monitoring

- To verify that operational and engineered controls effectively prevent groundwater contamination.

- To trigger early action and communication, should the unexpected happen (e.g., control failure).
- To determine the efficacy of the operational and engineered control measures designed to protect the groundwater.
- To demonstrate compliance with applicable requirements for protecting and remediating groundwater.

Groundwater -CERCLA Monitoring

- To track a dynamic groundwater cleanup problem when designing, constructing, and operating treatment systems.
- To measure the performance of the groundwater remediation efforts in achieving cleanup goals.
- To protect public health and the environment during the cleanup period.
- To define the extent and degree of groundwater contamination.
- To provide early warning of the arrival of a leading edge of a plume, which could trigger contingency remedies to protect public health and the environment.

The details of the monitoring are described in the *BNL 2009 Environmental Monitoring Plan* (BNL 2009a). This plan includes a description of the source area, description of groundwater quality, criteria for selecting locations for groundwater monitoring, and the frequency of sampling and analysis. **Figure 1-1** highlights BNL's operable unit (OU) locations designated as part of the CERCLA program, and key site features. Details on the sampling parameters, frequency, and analysis by well are listed on **Tables 1-5** and **1-6**. Screen zone, total depth, and ground surface elevations have been summarized on **Table 1-7**. **Figure 1-2** shows the locations of wells monitored as part of the Laboratory's groundwater protection program. Detailed groundwater monitoring rationale can be found in the *BNL 2009 Environmental Monitoring Plan*. BNL's CERCLA groundwater monitoring has been streamlined into five general phases **(Table 1-8)**:

Start-up Monitoring

A quarterly sampling frequency is implemented on all wells for a period of two years. This increased sampling frequency provides sufficient data while the system operation is in its early stages.

Operations and Maintenance (O&M) Monitoring

This is a period of reduced monitoring during the time when the system is in a routine operational state. The timeframe for each system varies. This phase is also utilized for several plume monitoring programs not requiring active remediation.

Shutdown Monitoring

This is a two-year period of monitoring implemented just prior to petitioning for system shut down. The increased sampling frequency provides the necessary data to support the shutdown petition.

Standby Monitoring

This is a period of reduced monitoring up to a five-year duration to identify any potential rebounding of contaminant concentrations. If concentrations remain below MCLs, the petition for closure and decommissioning of the system is recommended.

Post Closure Monitoring

This is a monitoring period of varying length for approximately 20% of the key wells in a given project following system closure. Monitoring continues until the Record of Decision (ROD) goal of meeting MCLs in the Upper Glacial aquifer is reached. This is expected to occur by 2030. This phase is considerably longer for the Magothy and Sr-90 cleanups due to greater length of the time to reach MCLs required for those projects.

Since 2001, BNL uses a structured Data Quality Objective (DQO) process to continually review and refine the groundwater monitoring and remediation projects. The results of the DQO reviews are documented annually in updates to the *BNL 2009 Environmental Monitoring Plan*.

Table 1-8. CERCLA Groundwater Monitoring Program – Well Sampling Frequency.

Project Activity Phase	Well Type	Phase Duration (yrs.)	Sampling Freq. (events/yr.)****
Start-up Monitoring	Plume Core	2	4x
Plum	e Perimeter	2	4x
Senti	nel/Bypass	2	4x
Operations & Maintenance (O&M) Monitoring	Plume Core	End Start-up to Shutdown*	2x
	Plume Perimeter	End Start-up to Shutdown*	2x
	Sentinel/Bypass	End Start-up to Shutdown*	4x
Shutdown Monitoring	Plume Core	2	4x
Plum	e Perimeter	2	4x
Senti	nel/Bypass	2	4x
Standby Monitoring	Key Plume Core	5	2x
Plum	e Perimeter	5	1x
Senti	nel/Bypass	5	2x
Post Closure Monitoring***	20% of key wells	Up To 2030**	1x

Notes:
*- Varies by project, see Table 1-5.
** - Magothy: 2065, BGRR Sr-90: 2070, S. Boundary Rad: 2038, Chem Holes Sr-90: 2045
*** - Verification monitoring for achieving MCLs.
****- Sr-90 monitoring projects use approximately half the defined sampling frequency.

The groundwater monitoring well networks for each program are organized into background, core, perimeter, bypass, and sentinel wells. The wells are designated as follows:

- Background –water quality results will be used to determine upgradient water quality
- Plume Core – utilized to monitor the high concentration or core area of the plume
- Perimeter – used to define the outer edge of the plume both horizontally and vertically
- Bypass – used to determine whether plume capture performance is being met
- Sentinel – An early warning well to detect the leading edge of a plume.

1.2 Private Well Sampling

During 2009, there were eight known homeowners in the residential area overlying the plume who continue to use their private wells for drinking water purposes. In accordance with the OU III and OU VI RODs, DOE formally offers these homeowners free testing of their private drinking water wells on an annual basis. SCDHS coordinates and performs the sampling and analysis. During 2009, three of the eight homeowners who were offered the free testing requested the sampling. The results from SCDHS indicate that there were no VOCs detected. However, one homeowner had iron detected in their well above standards. The groundwater in this section of Long Island often has naturally occurring iron at concentrations above standards.

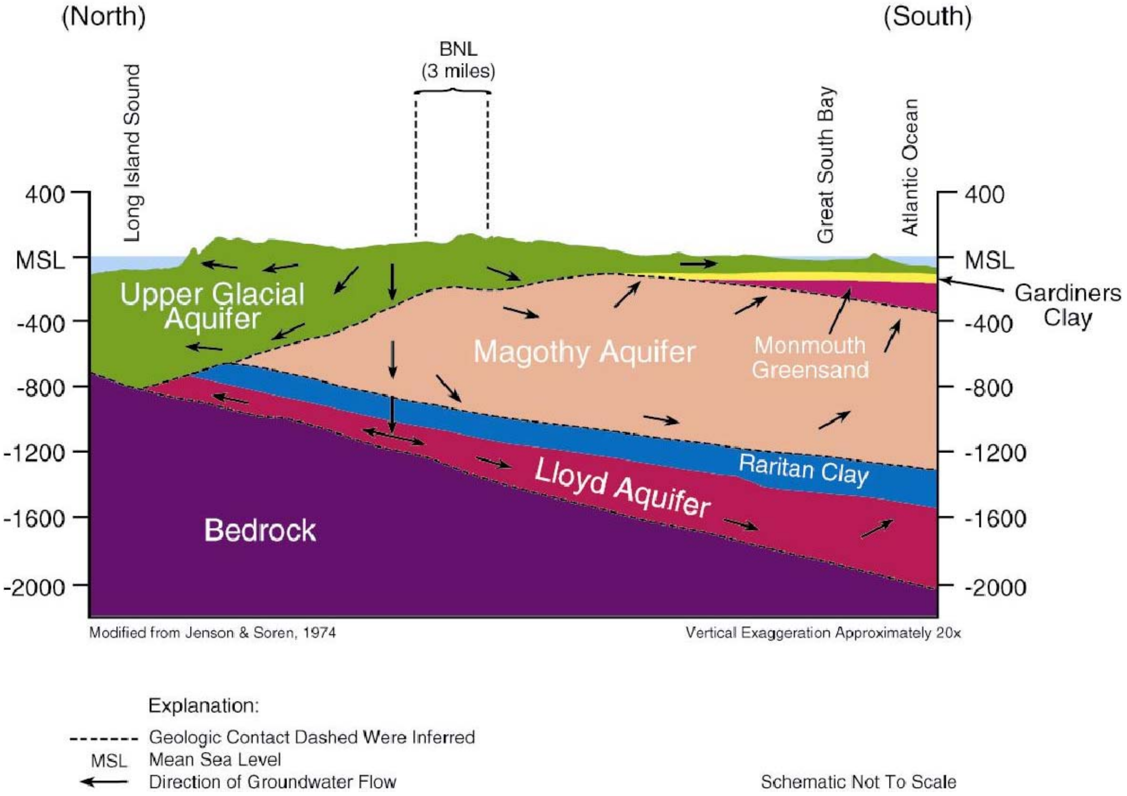
`

2.0 HYDROGEOLOGY

This section briefly describes the hydrogeologic environment at BNL and the surrounding area. It also summarizes the dynamics of the groundwater flow system in 2009, along with on-site pumping rates and rainfall recharge.

Detailed descriptions of the aquifer system underlying BNL and the surrounding areas are found in the U.S. Geological Survey (USGS) report by Scorca and others (1999), *Stratigraphy and Hydrologic Conditions at the Brookhaven National Laboratory and Vicinity, Suffolk County, New York, 1994–97,* and the USGS report by Wallace deLaguna (1963), *Geology of Brookhaven National Laboratory and Vicinity, Suffolk County, New York.* The stratigraphy below BNL consists of approximately 1,300 feet of unconsolidated deposits overlying bedrock (**Figure 2-1**). The current groundwater monitoring program focuses on groundwater quality within the Upper Pleistocene deposits (Upper Glacial aquifer), and the upper portions of the Matawan Group-Magothy Formation (Magothy aquifer).

Figure 2-1.
Generalized Geologic Cross Section in the Vicinity of Brookhaven National Laboratory.



The Pleistocene deposits are about 100–200 feet thick and are divided into two primary hydrogeologic units: undifferentiated sand and gravel outwash and moraine deposits, and the finer-grained, more poorly sorted Upton Unit. The Upton Unit makes up the lower portion of the Upper Glacial aquifer beneath several areas of the site. It generally consists of fine- to medium-grained white to greenish sand with interstitial clay. In addition to these two major hydrogeologic units, there are several other distinct hydrogeologic units within the Upper Glacial aquifer. They include localized, near-surface clay layers in the vicinity of the Peconic River (including the Sewage Treatment Plant [STP] area), and reworked Magothy deposits that characterize the base of the aquifer in several areas. The Gardiners Clay is a regionally defined geologic unit that is discontinuous beneath BNL and areas to the south. Typically, it is characterized by variable amounts of green silty clay, sandy and gravelly green clay, and clayey silt.

Where it exists, the Gardiners Clay acts as a confining or semi-confining unit that impedes the vertical flow and migration of groundwater between the Upper Glacial aquifer and the underlying Magothy aquifer.

The Magothy aquifer is composed of the continental deltaic deposits of the Cretaceous Age that unconformably underlie the Pleistocene deposits. The Magothy aquifer at BNL is approximately 800 feet thick, and because it is composed of fine sand interbedded with silt and clay, it is generally less permeable than the Upper Glacial aquifer. The Magothy aquifer is highly stratified. Of particular importance at BNL is that the upper portion of the Magothy contains extensive, locally continuous layers of grey-brown clay (referred to herein as the Magothy Brown Clay). Regionally, the Magothy Brown Clay is not interpreted as being continuous; however, beneath BNL and adjacent off-site areas, it acts as a confining unit (where it exists), impeding the vertical flow and movement of groundwater between the Upper Glacial and Magothy aquifers.

Regional patterns of groundwater flow near BNL are influenced by natural and artificial factors. **Figures 2-2 and 2-3** show the locations of pumping wells and recharge basins. Under natural conditions, recharge to the regional aquifer system is derived solely from precipitation. A regional groundwater divide exists immediately north of BNL near Route 25. It is oriented roughly east–west, and appears to coincide with the centerline of a regional recharge area. Groundwater north of this divide flows northward, ultimately discharging to the Long Island Sound (**Figure 2-1**). Shallow groundwater in the BNL area generally flows to the south and east. During high water-table conditions, that groundwater can discharge into local surface water bodies such as the Peconic River and adjacent ponds. The BNL site is within a regional deep-flow recharge area, where downward flow helps to replenish the deep sections of the Upper Glacial aquifer, the Magothy aquifer, and the Lloyd aquifer. South of BNL, groundwater flow becomes more horizontal and ultimately flows upward as it moves toward regional discharge areas such as the Carmans River and Great South Bay. Superimposed on the natural regional field of groundwater flow are the artificial influences due to pumping and recharge operations.

2.1 Hydrogeologic Data

Various hydrogeologic data collection and summary activities were undertaken as part of the 2009 Groundwater Protection Program to evaluate groundwater flow patterns and conditions. This work is described in the following sections and includes the results of groundwater elevation monitoring, information on pumping and recharging activities on and off site, and precipitation data.

2.1.1 Groundwater Elevation Monitoring

Synoptic water levels are obtained from a network of on-site and off-site wells screened at various depths within the Upper Glacial aquifer and upper portions of the Magothy aquifer. These data are used to characterize the groundwater flow-field (direction and rate) and to evaluate seasonal and artificial variations in its flow patterns. Additional water-level data from off-site wells are obtained from the USGS.

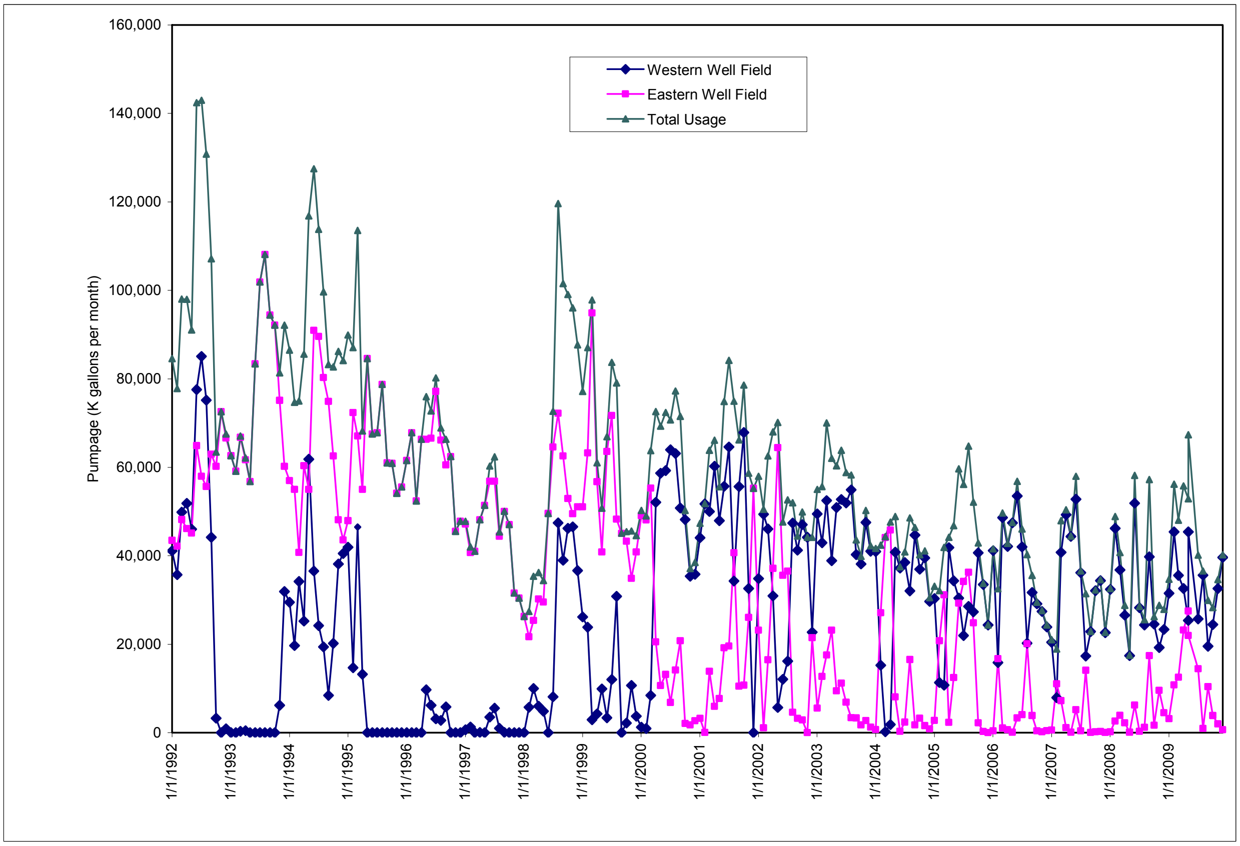
The synoptic water-level measurement events comprising the complete network of on-site and off-site wells were conducted in June 2009 with data collected from approximately 775 wells. Smaller scale synoptic measurement using wells located only in the central part of the BNL site were conducted in March and September 2009, with data collected from approximately 100 shallow Upper Glacial aquifer wells. Water levels were measured with electronic water-level indicators following the BNL *Environmental Monitoring Standard Operating Procedure* EM-SOP-300. **Appendix A** provides the depth-to-water measurements and the calculated groundwater elevations for these measurements. Monitoring results for long-term and short-term hydrographs for select wells are discussed in **Section 2.2**.

2.1.2 Pumpage of On-Site Water Supply and Remediation Wells

BNL operates six water supply wells to provide potable and process cooling water, and 61 treatment wells. All six water supply wells are screened entirely within the Upper Glacial aquifer. During 2009, 19 of the 61 treatment wells were in standby mode. **Figures 2-2** and **2-3** show the locations of the water supply and remediation wells. The effects the groundwater withdrawals have on the aquifer system are discussed in **Section 2.2**.

Table 2-1 provides the monthly and total water usage for 2009 for the six on-site potable supply wells (4, 6, 7, 10, 11, and 12). It includes information on each well's screened interval and pumping capacity. These wells primarily withdraw groundwater from the middle to deep sections of the Upper Glacial aquifer. The variation in monthly pumpage reflects changes in water demand, and maintenance schedules for the water supply system. The western potable well field includes wells 4, 6, and 7; the eastern field contains wells 10, 11, and 12. Supply well 12 has been out of service since October 2008, when a propane gas explosion destroyed the pump house and associated pump controls. The water supply operating protocols, which have been established by the BNL Water and Sanitary Planning Committee, currently require that the western well field be used as the primary source of water, with a goal of obtaining 75 percent or more of the site-wide water supply from that well field. Using the western well field minimizes the groundwater flow direction effects of supply well pumping on several segments of the groundwater contaminant plumes located in the center of the BNL site. **Figure 2-4** below summarizes monthly pumpage for the eastern and western well fields.

Figure 2-4.
Summary of BNL Supply Well Pumpage 1992 through 2009.



Since 1999, the implementation of effective water conservation measures has resulted in a significant reduction in the amount of water pumped from the aquifer. During 2009, a total of 525 million gallons of water were withdrawn from the aquifer, and BNL met its goal of obtaining more than 75 percent of its total water supply from the western well field. The western well field provided approximately 75 percent of the water supply, with most of the pumpage obtained from wells 6 and 7. Supply well 10 has been maintained in standby mode since 2000 due to the impacts it might have on contaminant plume flow directions in the central portion of the site (specifically on the g-2 tritium plume and the Waste Concentration Facility Sr-90 plume). However, with the loss of well 12 in October 2008, in early 2009 BNL started to use well 10 for short periods of time. **Table 2-2** summarizes the 2009 monthly water pumpage for the groundwater remediation systems. Additional details on groundwater remediation system pumping are provided in **Section 3** of this report.

2.1.3 Off-Site Water Supply Wells

Several Suffolk County Water Authority (SCWA) well fields are located near BNL. The William Floyd Parkway Well Field is west/southwest of BNL (**Figures 2-2 and 2-3**), and consists of three water supply wells that withdraw groundwater from the mid Upper Glacial aquifer and the upper portion of the Magothy aquifer. The Country Club Drive Well Field is south/southeast of BNL, and consists of three water supply wells that withdraw groundwater from the mid section of the Upper Glacial aquifer. Pumpage information for 1989 through 2009 is provided as **Figure 2-5.** In 2009, the William Floyd Parkway (Parr Village) and Country Club Drive Well Fields produced 456 and 318 million gallons for the year, respectively. The Lambert Avenue Well Field, located south of BNL, produced 297 million gallons for the year.

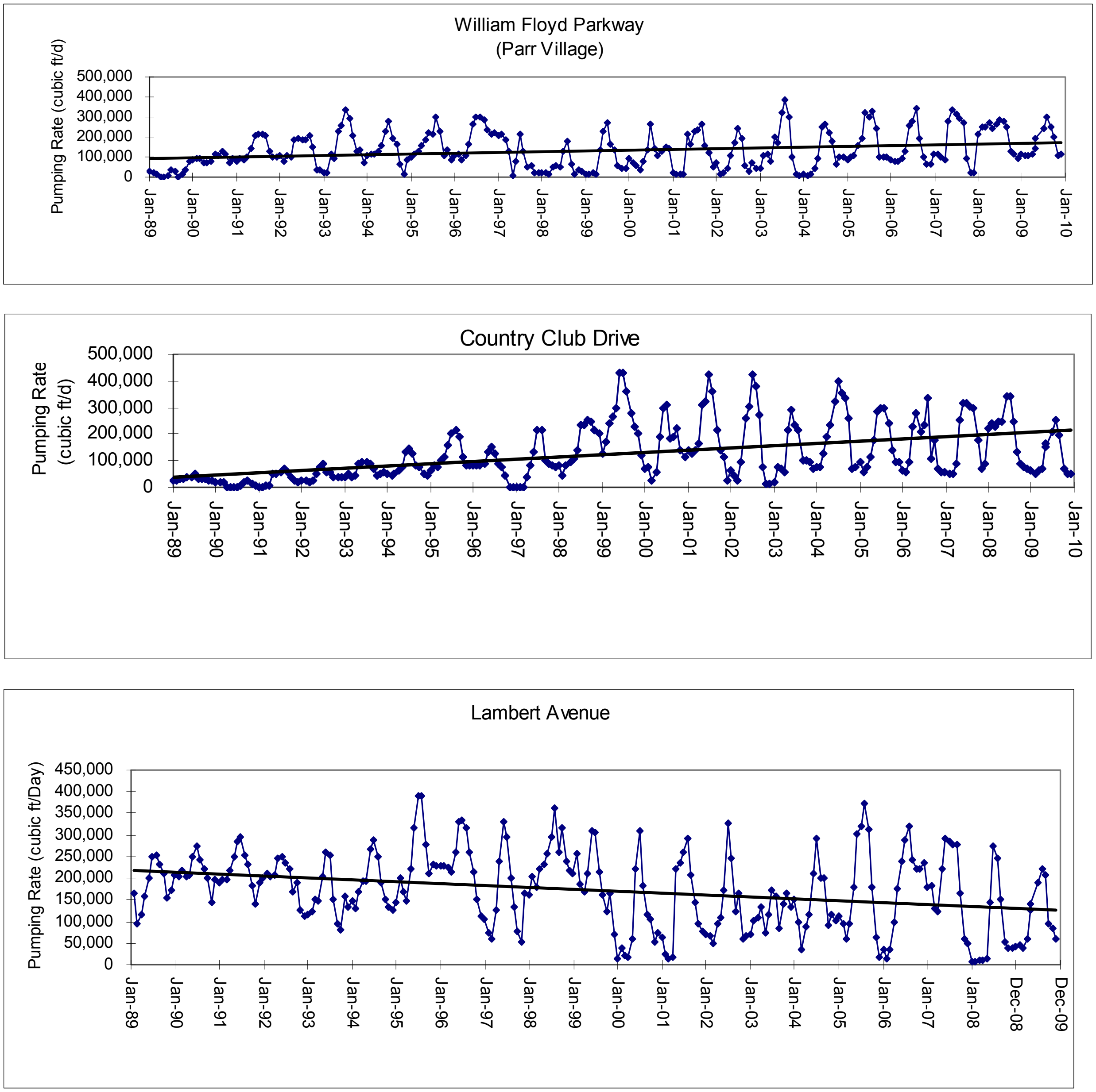
2.1.4 Summary of On-Site Recharge and Precipitation Data

This section summarizes artificial (i.e., on-site recharge basins) and natural recharge from precipitation. **Table 2-3** summarizes the monthly and total flow of water through 10 on-site recharge basins during 2009. Their locations are shown on **Figures 2-2 and 2-3**. **Section 2.2** (Groundwater Flow) provides a discussion on the effects associated with recharge. Seven of the basins (HN, HO, HS, HT-W, HT-E, HX, and HZ) receive stormwater runoff and cooling water discharges. Flow into these basins is monitored monthly per NYSDEC State Pollutant Discharge Elimination System (SPDES) permit requirements. Generally, the amount of water recharging through the groundwater system to these basins reflects supply well pumpage. Annual water supply flow diagrams show the general relationships between recharge basins and the supply wells, and are published in Volume I of the annual *Site Environmental Report (Chapter 5, Water Quality)*.

The remaining three basins (Removal Action V [RA V], OU III, and Western South Boundary) were constructed to recharge water processed through several of the groundwater remediation systems. Until September 2001, treated groundwater from the OU III South Boundary Pump and Treat System was discharged solely to the OU III basin, adjacent to former recharge basin HP along Princeton Avenue. After September 2001, groundwater from that system and the OU III Middle Road and High Flux Beam Reactor (HFBR) systems was discharged equally to the OU III and RA V basins. Treated groundwater from the OU I South Boundary is discharged to the RA V basin. **Table 2-3** gives estimates of flow to these basins. The discharge to these basins for 2009 (16 and 30 million gallons per month, average, for the OU III and RA V basins, respectively) is significantly greater than that from other individual on-site basins. Pulse pumping and the placement of several groundwater remediation extraction wells on standby resulted in an overall decrease of discharge totals.

Other important sources of artificial recharge, not included on **Table 2-3**, include a stormwater retention basin referred to as HW (on Weaver Drive), and the sand filter beds at the STP. The sand filter beds causes localized mounding of the water table. Of the approximately 300,000 gallons of wastewater treated at the STP each day, about 20 percent of the treated effluent seeps directly to the underlying water table beneath the filter beds tile-drain collection system, and the remaining treated effluent is discharged to the Peconic River. Most of the water released to the Peconic River recharges to the aquifer before it reaches the BNL site boundary, except during times of seasonally high water levels.

Figure 2-5.
Suffolk County Water Authority Pumping Near BNL.



Precipitation provides the primary recharge of water to the aquifer system at BNL. In an average year, approximately 24 inches of precipitation recharges the Upper Glacial aquifer. Under long-term conditions in undeveloped areas of Long Island, about 50 percent of precipitation is lost through evapotranspiration and direct runoff to streams; the other 50 percent infiltrates the soil and recharges the groundwater system (Aronson and Seaburn 1974; Franke and McClymonds 1972). In 2009, it is estimated that the recharge at BNL was approximately 27 inches. **Table 2-4** summarizes monthly and annual precipitation results from 1949 to 2009 collected on site by BNL Meteorology Services. Variations in the water table generally can be correlated with seasonal precipitation patterns. As depicted on **Table 2-4**, total annual precipitation in 2009 was 54.17 inches, which was above the long-term yearly average of 48.85 inches. Nine of the past 12 years have featured above-normal annual average precipitation at BNL.

2.2 Groundwater Flow

BNL routinely monitors horizontal and vertical groundwater flow directions and rates within the Upper Glacial aquifer and uppermost Magothy aquifer by using water-level data collected from a large network of on-site and off-site monitoring wells. Short-term and long-term seasonal fluctuations of water levels are also evaluated using hydrographs for select wells, and trends in precipitation.

2.2.1 Water-Table Contour Map

Figure 2-2 is a groundwater elevation contour map representing the configuration of the water table for June 2009. The contours were generated from the water-level data from shallow Upper Glacial aquifer wells, assisted by a contouring package (Quick SURF). Localized hydrogeologic influences on groundwater flow were considered, including on-site and off-site pumping wells, and on-site recharge basins (summarized in **Section 2.1**).

Groundwater flow in the Upper Glacial aquifer is generally characterized by a southeasterly component of flow in the northern portion of the site, with a gradual transition to a more southerly direction at the southern boundary and beyond. Flow directions in the eastern portion of BNL are predominately to the east and southeast (**Figure 2-2**). The general groundwater flow pattern for 2009 was consistent with historical flow patterns. As described in **Section 2.1.2**, the water supply operating protocols established by BNL in late 2005 require that the western well field be used as the primary source of water, with a goal of obtaining 75 percent or more of the site's water supply from these wells. This protocol has resulted in a more stable south-southeast groundwater flow direction in the central portion of the site.

Localized man-made disturbances to groundwater flow patterns are evident on the groundwater contour maps. They result primarily from active on-site and off-site well pumpage and the discharge of water to on-site recharge basins. Influences from the pumping wells can be seen as cones of depressions, most notably near potable supply wells 4 and 7, and near the groundwater treatment wells along the southern boundary (**Figure 2-2**).

Influences from water recharge activities can be observed as localized mounding of the water table, particularly around recharge basin OU III and the RA V basin (in the center of the site), and the STP. The degree of mounding is generally consistent with the monthly flows to recharge basins summarized in **Section 2.1**. However, the extent of some of the mounding also reflects the ability of the underlying deposits to transmit water, which varies across the site. For example, the volume of recharged water at the STP sand filter beds typically is not as great as that at recharge basin OU III or the RA V basin. However, the presence of near-surface clay layers underlying portions of the STP sand filter beds results in an extensive groundwater mound.

Other noteworthy features are the influence that surface water bodies have on groundwater flow directions. **Figure 2-2** shows groundwater flowing towards the Carmans River in areas south/southwest of BNL. This pattern is consistent with the fact that the Carmans River is a significant discharge boundary.

2.2.2 Deep Glacial Contour Map

Figure 2-3 shows the potentiometric surface contour map of the deep zone of the Upper Glacial aquifer for June 2009. The contours were generated in the same manner as the water-table contours, but using water-level data from wells screened only within the deep sections of the Upper Glacial aquifer.

The 2009 patterns for groundwater flow in the deep Upper Glacial are similar to those in the shallow (or water-table) zone. They are characterized by a southeasterly component in the northern portion of the site, with a gradual transition to a more southerly flow at the southern site boundary and beyond. In areas south/southwest of BNL, the deep glacial contour map also indicates flow toward the Carmans River. The localized influences of pumping on the potentiometric surface configurations are evident as cones of depression. As with the water-table configurations, variations in these localized hydrogeologic effects are attributed to the monthly variations in pumpage.

Although the localized influences of recharging on the potentiometric surface configurations are evident for the deep Upper Glacial aquifer, they are not as pronounced as those observed at the water table. Such hydrogeologic effects generally decrease with depth in the aquifer. Furthermore, mounding is not present beneath the STP sand filter beds because mounding is controlled by shallow, near-surface clay layers. Finally, the surface water/groundwater interactions that take place along the Peconic River in the vicinity of BNL do not influence the deep glacial zone.

2.2.3 Well Hydrographs

Groundwater hydrographs are useful in estimating recharge rates and the location of the water table relative to contaminant sources. Long-term (typically 1950–2009) and short-term (1997–2009) well hydrographs were constructed from water-level data that were obtained for select USGS and BNL wells, respectively. These hydrographs track fluctuations in water level over time. Precipitation data also were compared to natural fluctuations in water levels. **Appendix B** contains the well hydrographs, together with a map depicting the locations of these wells.

A long-term hydrograph was constructed from historical water-level data from BNL well 065-14 (NYSDEC # S-5517.1; USGS Site Number 405149072532201). This well was installed by the USGS for the DOE in the late 1940s. The well is located near the BNL Brookhaven Center building, and is screened in the Upper Glacial aquifer close to the water table. The USGS has collected monthly water-level information from this well from 1953 through 2005. In 2006, the USGS installed a real time continuous water-level recorder in the well. Data from this monitoring station can be accessed on the World Wide Web at: http://groundwaterwatch.usgs.gov/AWLSites.asp?S=405149072532201&ncd=rtn.

The long-term hydrographs indicate that typical seasonal water-table elevation fluctuations are on the order of 4 to 5 feet. Some of the water-table elevation changes have occurred during prolonged periods of low precipitation, where a maximum fluctuation of nearly 14 feet was observed during the regional drought of the early 1960s.

Short-term hydrographs from three well clusters (well cluster 075-39/075-40/075-41, 105-05/105-07/105-24, and 122-01/122-04/122-05) are used to evaluate water-table fluctuations and fluctuations in vertical gradients from 1999 through 2009. Generally, the highest groundwater elevations can be observed during the March-May time period in response to snow melt and spring rains. Normally, the position of the water table drops through the summer and into the fall.

2.2.4 Groundwater Gradients and Flow Rates

Evaluation of the horizontal hydraulic gradients provides information on the driving force behind groundwater flow. These gradients can be used with estimates of aquifer parameters such as hydraulic conductivity (175 feet per day [ft/day]) and effective porosity (0.24) to assess the velocities of groundwater flow. The horizontal hydraulic gradient at the BNL site is typically 0.001 feet per foot (ft/ft), but in recharge and pumping areas it can steepen to 0.0024 ft/ft or greater. The natural groundwater flow velocity in most parts of the site is estimated to be approximately 0.75 ft/day, but flow velocities in recharge areas can be as high as 1.45 ft/day, and those in areas near BNL supply wells can be as high as 28 ft/day (Scorca et al. 1999).

2.3 New Geologic Data

Although a number of new wells were drilled at the BNL site during 2009, most of the geologic information obtained during their installation was consistent with previous investigations.

2.4 Monitoring Well Maintenance Program

BNL has a program to maintain its groundwater monitoring wells which includes maintaining the protective casings, concrete pads and sample pumps. During 2009, BNL conducted an extensive maintenance campaign aimed at repainting all of the protective casings for all on-site wells. BNL was able to repaint most of the casings, except for those located within the RHIC facility, where Collider operations prohibited work crews from entering the area.

3.0 CERCLA GROUNDWATER MONITORING AND REMEDIATION

Chapter 3 gives an overview of groundwater monitoring and remediation efforts at BNL during 2009. The chapter is organized first by Operable Unit, and then by the specific groundwater remediation system and/or monitoring program. **Figure 1-2** shows the locations of monitoring wells throughout the site by project. Monitoring well location maps specific to particular monitoring programs are included throughout **Section 3**.

Report and Data on CD

Appendices C and D contain the analytical results for each sample. Due to the large volume of data, these appendices are included on a CD-ROM; this significantly reduces the size of the hardcopy of this report. The CD-ROM has a table of contents with active links, such that, by selecting the specific project and analytical suite, the user will be directed to the associated table of results. The groundwater results are arranged by specific monitoring project and then by analytical group (e.g., VOCs, SVOCs, metals, chemistry, pesticides/PCBs, and radionuclides). The data are further organized by well ID and the collection date of the sample. Chemical/radionuclide concentrations, detection limits, and uncertainties are reported, along with a data verification, validation, and/or usability qualifier (if assigned), and/or a laboratory data qualifier. If a data verification/validation qualifier was not assigned, the laboratory data qualifier is presented. Results that exceed the corresponding groundwater standard or guidance criteria (**Section 1.1.1** [Regulatory Requirements]) are in bold text. The complete analytical results are included to allow the reader the opportunity for detailed analysis. In addition, this entire report is included on the CD-ROM with active links to tables and figures.

About the Plume Maps

Maps are provided that depict the areal extent and magnitude of the contaminant plumes. In most cases, the VOC plumes were simplified by using the total VOC (TVOC) values for drawing the contours, except for those plumes that consist almost exclusively of one chemical, such as the OU III Carbon Tetrachloride plume and the OU VI Ethylene Dibromide (EDB) plume. TVOC concentrations are a summation of the individual concentrations of VOCs analyzed by EPA Method 524.2.

The extent of plumes containing VOC contamination was contoured to represent concentrations that were greater than the typical NYS AWQS of 5 micrograms per liter (µg/L) for most compounds. Radionuclide plumes were contoured to their appropriate drinking water standard (DWS). **Figure 3.0-1** shows the VOC and radionuclide plumes as well as the locations and groundwater capture zones for each of the treatment systems.

Following the capping of the landfill areas and the beginning of active groundwater remediation systems in 1997, there have been significant changes in the size and concentrations of several of the VOC plumes. These changes can be attributed to the following:

- The beneficial effects of active remediation systems
- Source control and removal actions
- The impacts of BNL pumping and recharge on the groundwater flow system
- Radioactive decay, biological degradation, and natural attenuation

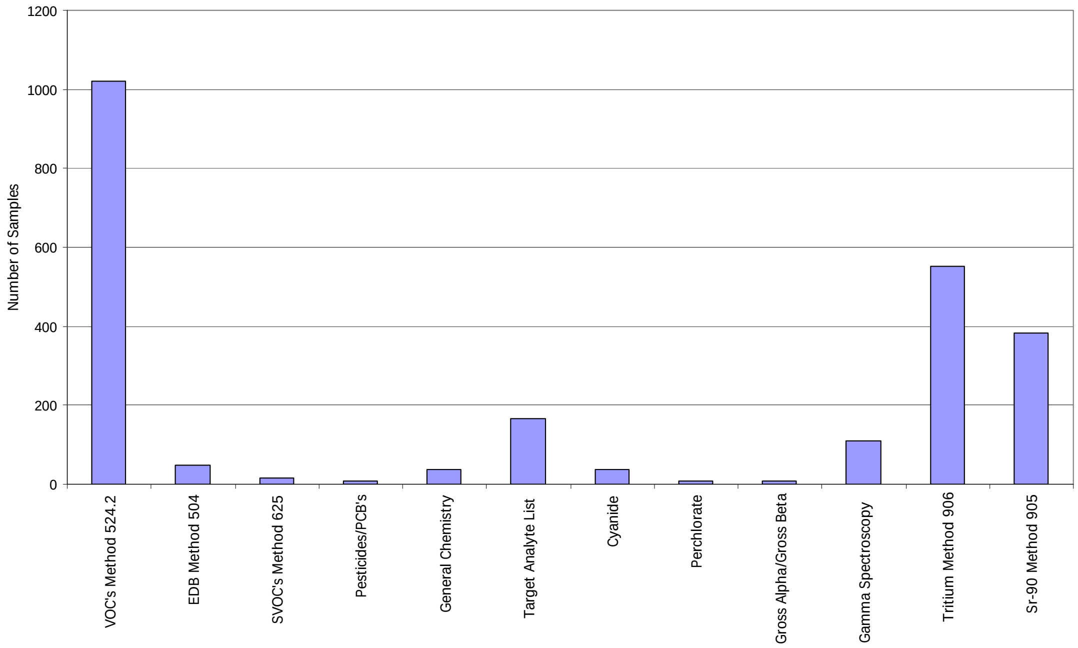
Additionally, BNL's ability to accurately depict these plumes has been enhanced over the years by the:

- installation of additional permanent monitoring wells to the existing well networks
- installation of temporary wells that helped to fill in data gaps

During 2009, the contaminant plumes were tracked by collecting 1,617 groundwater samples obtained from 698 on-site and off-site monitoring wells. **Figure 3.0-2** below provides a summary of the number of analyses performed, arranged by analytical method. Unless otherwise noted, the extent of contamination for a given plume is depicted by primarily using 2009 data from permanent monitoring wells. In several cases, data from temporary wells installed during the first three months of 2010 were utilized. Contaminant plumes associated with OU I South Boundary, HFBR Tritium, Brookhaven Graphite Research Reactor/Waste Concentration Facility (BGRR/WCF) Sr-90, Building 96, OU IV AOC 6 and g-2 Tritium Plume projects were further defined in 2009 or the first three months of 2010 using temporary wells (i.e., direct push Geoprobes® or vertical profiles).

A single representative round of monitoring data was usually chosen for each plume, typically from the last quarter of the year because it includes the most comprehensive sampling round for the year. This report also serves as the fourth quarter operations report for the remediation systems. Contaminant concentration trend plots for key monitoring wells in each plume are provided to identify significant changes. Data from monitoring wells sampled under BNL's Facility Monitoring Program are evaluated in **Section 4.0**.

Figure 3.0-2.
Summary of Laboratory Analyses Performed for the CERCLA Monitoring Well Program in 2009.



History and Status of Groundwater Remediation at BNL

Groundwater remediation systems have operated at BNL since 1997 beginning with the OU I South Boundary Pump and Treat System. The goal of groundwater remediation, as defined by the OU III Record of Decision, is to prevent or minimize plume growth and not to exceed MCLs in the Upper Glacial aquifer within 30 years or less (by 2030). Based on additional information obtained during the Strontium-90 Pilot Study, the *OU III Explanation of Significant Differences* (BNL 2005a) identified changes to the cleanup goal timeframes for the Sr-90 plumes. For the BGRR/WCF and Chemical Holes Sr-90 plumes, MCLs must be reached by 2070 and by 2040, respectively. In addition, cleanup of the Magothy aquifer VOC contamination must meet MCLs by 2065.

There are currently 14 groundwater remediation systems in operation. One system remains in standby mode (the Carbon Tetrachloride Pump and Treat System) and a Petition for Closure is being prepared. Another system has met its cleanup goals and has been decommissioned: the OU IV, Area of Concern (AOC) 5, Air Sparge/Soil Vapor Extraction System (OU IV AS/SVE). **Figure 3.0-1** shows the locations and groundwater capture zones for each of the treatment systems. In addition to the groundwater treatment systems, two landfill areas (Current and Former) were capped, which minimizes the potential for groundwater contamination.

BNL’s Facilities and Operations personnel perform routine maintenance checks on the treatment systems in addition to their routine and non-routine maintenance. BNL’s Environmental Protection Division (EPD) collects the treatment system performance samples. In 2009, 1,272 treatment system samples were obtained from 104 sampling points. The data from the treatment system sampling is available in **Appendix F** tables. Full details of the maintenance checks are recorded in the system’s operation and maintenance daily inspection logs. The daily logs are available at the treatment facility, or in the project files.

In general, BNL uses two types of groundwater remediation systems to treat VOC contamination: pump and treat with air stripping or carbon treatment, or recirculation wells with air stripping or carbon treatment. Pump and treat remediation consists of pumping groundwater from the plume up to the surface and piping it to a treatment system, where the contaminants are removed by either air stripping or granular activated carbon. Treated water is then introduced back into the aquifer via recharge basins, injection wells, or dry wells. BNL utilizes pump and treat using ion-exchange resin for remediating Sr-90. Pump and recharge (without treatment) is utilized to hydraulically contain the HFBR tritium plume. Starting in 2008, BNL also used ion-exchange treatment for localized hexavalent chromium groundwater contamination at Building 96.

Table 3.0-1 summarizes the operating remediation systems. Groundwater remediation at BNL is proceeding as projected. As discussed in the following sections, groundwater modeling is also used as a tool to help determine if remediation of the plumes is proceeding as planned to meet the overall groundwater cleanup goals. When modifications to the remediation systems are necessary, the groundwater model is also used as a tool to aid in the design.

Table 3.0-1. 2009 Summary of Groundwater Remediation Systems at BNL.

Operable Unit System	Type	Target Contaminant	No. of Wells	Years in Operation	Recharge Method	Pounds VOCs Removed in 2009/Cumulative
Operable Unit I						
South Boundary	P&T, AS	VOC	2	12	Basin	6/353
Operable Unit III						
South Boundary	P&T, (AS)	VOC	7	12	Basin	85/2,715
HFBR Pump and Recharge	Pump and Recirculate	Tritium 4		Operate: 5.5 Standby: 7.5	Basin	0/180
Industrial Park	Recirculation/ In-Well (AS/Carbon)	VOC 7		10	Recirculation Well	12/1,045
*Carbon Tet	P&T (Carbon)	VOC	3	Operate: 5 Standby: 5	Basin	NA/349
****Building 96	Recirculation Well (AS/Carbon)	VOC 4		Operate: 6 Standby: 3	Recirculation Well	9/107
Middle Road	P&T (AS)	VOC	6	8	Basin	63/862
Western South Boundary	P&T (AS)	VOC	2	7	Basin	12/66
Chemical Holes	P&T (IE)	Sr-90	3 7 Dry		Well	0.46**/3.79
North Street	P&T (Carbon)	VOC	2	5	Wells	10/300
North Street East	P&T (Carbon)	VOC	2	5	Wells	6/30
LIPA/Airport	P&T and Recirc. Wells (Carbon)	VOC	10	5	Wells and Recirculation Well	23/283
Industrial Park East	P&T (Carbon)	VOC	2	5	Wells	3/38
BGRR/WCF	P&T (IE)	Sr-90	5	4	Dry Wells	1.4**/17.5
Operable Unit VI						
EDB P&T	(Carbon)	EDB	2	5	Wells	NA***

Notes:
AS = Air Stripping
AS/SVE = Air Sparging/Soil Vapor Extraction
EDB = ethylene dibromide
IE = Ion Exchange
LIPA = Long Island Power Authority
NA = Not Applicable
* This system was shut down August 1, 2004 and put in standby mode.
P&T = Pump and Treat
Recirculation = Double screened well with discharge of treated water back to the same well in a shallow recharge screen
In-Well = The air stripper in these wells is located in the well vault.

** Sr-90 removal is expressed in mCi.
*** EDB was only detected in the system influent in 2009 below the standard. Therefore, no removal of VOCs is reported.
**** Well RTW-1 was modified from a recirculation well to surface discharge in May 2008. At the same time, hexavalent chromium treatment via ion-exchange resin was also added to RTW-1.

3.1 OPERABLE UNIT I

The two sources of groundwater contamination contained within the OU I project are the former Hazardous Waste Management Facility (HWMF) and the Current Landfill. The former HWMF was BNL’s central RCRA receiving facility for processing, neutralizing, and storing hazardous and radioactive wastes for off-site disposal until 1997, when a new Waste Management Facility was constructed along East Fifth Avenue. Several hazardous materials spills were documented at the former HWMF. A soil remediation program was completed for this facility in September of 2005.

The plumes from the Current Landfill and former HWMF became commingled south of the former HWMF. The commingling was partially caused by the pumping and recharge effects of a spray aeration system, which operated from 1985 to 1990. This system was designed to treat VOC-contaminated groundwater originating from the former HWMF. The VOC plume is depicted on **Figure 3.1-1**.

The on-site segment of the Current Landfill/former HWMF plume is being remediated by a groundwater pump and treat system consisting of two wells screened in the deep portion of the Upper Glacial aquifer at the site property boundary (OU I South Boundary Treatment System). The extracted groundwater is treated for VOCs by air stripping, and is recharged to the ground at the RA V basin, located northwest of the Current Landfill (**Figure 3.1-1**). A second system (North Street East System) was built to treat the off-site portion of the plume. The off-site groundwater remediation system began operations in June 2004 and was included under the Operable Unit III Record of Decision (**Section 3.2.9**).

Tritium was detected in several on-site monitoring wells at concentrations below the 20,000 pico Curies per liter (pCi/L) DWS in 2009. Sr-90 was detected in several on-site permanent and temporary wells exceeding the 8 pCi/L DWS in 2009, as discussed in **Section 3.1.5.**

3.1.1 OU I South Boundary Pump and Treat System

This section summarizes the operational and monitoring well data for 2009 from the OU I South Boundary Groundwater Pump and Treat System, and presents conclusions and recommendations for its future operation. This system began operating in December 1996.

Three quarterly reports were prepared with the operational data from January 1, 2009 through September 30, 2009. This Report also serves as a summary of the fourth quarter operational data. Discharge Monitoring Reports for treated effluent water from the air-stripping tower were submitted to EPA and NYSDEC each month.

3.1.2 System Description

For a complete description of the OU I South Boundary Treatment System, see the *Operations and Maintenance Manual for the RA V Treatment Facility* (BNL 2005b).

3.1.3 Groundwater Monitoring

Well Network

The OU I South Boundary monitoring program uses a network of 46 monitoring wells (**Figure 1-2).** A discussion of monitoring well data specific to the Current Landfill source area is provided in BNL *2009 Environmental Monitoring Report, Current and Former Landfill Areas* (BNL, 2010a).

Sampling Frequency and Analysis

The wells are monitored as per the schedule provided on **Table 1-5**. A groundwater characterization was conducted in 2009 of the Sr-90 contamination which included the installation and sampling of 15 temporary wells.

3.1.4 Monitoring Well VOC Results

Figure 3.1-1 shows the areal extent of VOC contamination from the Current Landfill/former HWMF area based on the full round of samples collected in the third and fourth quarters of 2009. The primary VOCs detected in the on-site segment of this plume include chloroethane and 1,1-dichloroethane (DCA), which originated from the Current Landfill. The VOCs prevalent in the off-site segment of the plume (North Street East) are 1,1,1-trichloroethane (TCA), 1,1-dichloroethylene (DCE), trichloroethylene (TCE), and chloroethane. TVOC concentrations less than 30 µg/L are currently detected in monitoring wells immediately downgradient of the Current Landfill. The landfill was capped in November 1995 and the leading edge of the VOC plume appears to be attenuating to TVOC levels below 5 µg/L approximately 750 feet southeast of the landfill footprint.

The OU I South Boundary/North Street East plume (defined by TVOC concentrations greater than 5 µg/L) extends from south of the former HWMF to the site boundary (a distance of approximately 1,800 feet), where it has been hydraulically cut off from the off-site segment of the plume by extraction wells EW-1 and EW-2. The area of the plume displaying the highest TVOC concentrations (greater than 50 µg/L) was in the vicinity of monitoring well 107-40. The off-site portion of the plume is discussed in **Section 3.2.9,** the North Street East Pump and Treat System.

Figure 3.1-2 shows the vertical distribution of VOCs. The transect line for cross-section A–A' is shown on **Figure 3.1-1**. DCA and chloroethane are primarily detected in the shallow zone of the Upper Glacial aquifer near the source areas, and in the deep Upper Glacial at the site boundary and off site. TCA, DCE, TCE, chloroethane, and chloroform are found in the mid to deep Upper Glacial aquifer off site, south of North Street.

The plume remains bounded by the current network of wells. **Figure 3.1-3** gives the historical trends in VOC concentrations for key plume core and bypass wells that monitor the plume. **Appendix C** has a complete set of 2009 analytical results for the 44 wells. Significant findings for 2009 include:

- The trailing edge of the OU I South Boundary plume appears to have migrated to the vicinity of plume core well 107-41 based on a reduction in TVOC concentrations in this well over the past 2 years from 37 µg/L in 2008 to 15 µg/L in August 2009. The first quarter 2010 TVOC results for this well showed 3 µg/L. This well is screened in the Upton Unit immediately above the Gardiners Clay.
- The highest remaining VOC concentrations are currently located from south of well 107-41 to EW-1 and EW-2 located at the site boundary. Due to the presence of all or part of this portion of the plume within the Upton Unit and Gardiners Clay, the rate at which VOCs are migrating south towards EW-1 and EW-2 appears to be significantly reduced. This is due to the lower hydraulic conductivity of these materials in comparison to the Upper Glacial aquifer sands. It is difficult to determine whether this higher concentration segment has reached the extraction wells based on VOC concentrations in the influent due to the high rate of pumping and resulting dilution of VOC concentrations from samples collected in these wells. There has been no discernable increase in VOCs in monitoring well 115-14 which is located immediately adjacent and downgradient to EW-1. This well is not optimally positioned to detect VOCs prior to their capture at EW-1.
- There were no detections of VOCs above NYS AWQS in perimeter wells.
- VOC concentrations in bypass wells 115-42 and 000-138 remained at levels below NYS AWQS in 2009. VOCs greater than NYS AWQS continue to be hydraulically contained at the site boundary.

3.1.5 Radionuclide Monitoring Results

A subset of the OU I Monitoring Program wells is analyzed for tritium and Sr-90 semiannually, and gamma spectroscopy annually. The complete results for these wells are provided in **Appendix C**.

The tritium concentration in the sampled wells continues to be significantly below the 20,000 pCi/L DWS. The highest tritium concentration during 2009 was in well 115-14 (adjacent to EW-1) at 1,690 pCi/L. A plot of historical tritium results for select OU I South Boundary program wells is shown on **Figure 3.1-4**.

There are 10 wells used to monitor Sr-90 contamination from the former HWMF **(Table 1-5)**. These wells were supplemented in 2009 with 17 temporary wells based on a recommendation in the 2008 Report (see **Figure 3.1-5** and **Figure 3.1-6** for locations and **Table 3.1-1** for data). The purpose of the Sr-90 characterization was to get an update on the area of Sr-90 contamination originally characterized in 2001. At that time, this area was approximately 100 to 150 feet in width by 200 to 300 feet in length. The highest concentration detected was 65 pCi/L at a location approximately 300 feet southwest of monitoring well 099-04 at a depth of 56 feet bls. Sentinel monitoring wells 107-34, 107-35, 108-43, and 108-44 were installed several hundred feet south of the leading edge of the Sr-90 in 2001. Sr-90 was detected in well 107-35 for the first time during the second half of 2004 at a maximum concentration of 2.6 pCi/L. Concentrations in this well have slowly increased to 17 pCi/L in February 2009. This sentinel well is approximately 1,000 feet from the site boundary. The source of this area of Sr-90 contamination is the former HWMF, and based on a 40 foot per year migration rate in the aquifer this area of contamination probably dates back approximately 50 years. The location of permanent and temporary wells and the extent of Sr-90 concentrations is shown on **Figure 3.1-5**. Sr-90 concentration trends for key monitoring wells are provided on **Figure 3.1-7**.

Although the current characterization effort is not completed the results to date indicate that the leading edge of the Sr-90 contamination is approximately 250 feet south of well 107-35. The highest concentration detected was 29 pCi/L in GP-18. This is approximately 250 feet south of the maximum detection of 65 pCi/L detected during the 2001 characterization.

3.1.6 System Operations

The extraction wells are currently sampled quarterly. The influent and effluent of the air-stripper tower are sampled monthly for VOCs and weekly for pH. **Table 3.1-2** provides the effluent limitations for meeting the requirements of the SPDES equivalency permit. The system continued full-time operation in 2009 following a period of pulse pumping that was implemented from September 2005 through July 2007.

Table 3.1-2.
OU I South Boundary Pump and Treat System
2009 SPDES Equivalency Permit Levels

Parameters	Permit Level	Max. Measured Value
pH	6.0 – 9.0 SU	6.4 – 8.0 SU
Benzene	0.8 µg/L	<0.50 µg/L
Chloroform	7.0 µg/L	<0.50 µg/L
Chloroethane	5.0 µg/L	<0.50 µg/L
1,2-Dichloroethane	5.0 µg/L	<0.50 µg/L
1,1-Dichloroethene	5.0 µg/L	<0.50 µg/L
1,1,1-Trichloroethane	5.0 µg/L	<0.50 µg/L
Carbon tetrachloride	5.0 µg/L	<0.50 µg/L
1,2-Dichloropropane	5.0 µg/L	<0.50 µg/L
Methylene chloride	5.0 µg/L	<0.50 µg/L
Trichloroethylene	5.0 µg/L	<0.50 µg/L
Vinyl chloride	2.0 µg/L	<0.50 µg/L
1,2-Xylene	5.0 µg/L	<0.50 µg/L
Sum of 1,3- & 1,4-Xylene	10.0 µg/L	<0.50 µg/L

Notes:
SU = Standard Units
Required sampling frequency is monthly for VOCs and weekly for pH.

The following is a summary of the OU I operations for 2009:

January–September 2009
The system operated normally during the first quarter with only minor electrical and communication problems. During the second quarter the system was impacted by a number of electrical problems which resulted in the system being off for three weeks while repairs were being made. During the third quarter EW-2 was off for electrical repairs and modifications.

October–December 2009
The system operated normally during the last quarter of 2009.

3.1.7 System Operational Data

Extraction Wells
During 2009, 172 million gallons of groundwater were pumped and treated by the OU I system, with an average flow rate of 330 gallons per minute (gpm) for the year. **Table 2-3** contains the monthly pumping data for the two extraction wells. **Table 3.1-3** contains the monthly extraction well pumping rates. VOC and tritium concentrations in samples from EW-1 and EW-2 are provided on **Table F-1**. TVOC levels in both wells continued to show a slight decreasing trend with time (**Figure 3.1-8**). Year-end tritium levels were below detection limits in both wells.

System Influent and Effluent
VOC concentrations in 2009 for the air-stripper influent and effluent are summarized on **Tables F-2** and **F-3**. The influent concentrations of TCA and DCA generally have displayed an overall decrease over the 13 years of OU I South Boundary System operation.

The air-stripper system effectively removed all contaminants from the influent groundwater. All 2009 effluent data for this system were below the analytical method detection limit and below the regulatory limit specified in the equivalency permit conditions.

Table 3.1-4
OU I South Boundary
2009 Air Stripper VOC Emissions Data

Parameter	Allowable ERP* (lb/hr)	Actual** ERP* (lb/hr)
Carbon tetrachloride	0.016	0.0000
Chloroform 0.00	86	0.0002
1,1-Dichloroethane 10**		0.00025
1,2-Dichloroethane 0.01	1	0.0000
1,1-Dichloroethylene 0.19	4	0.0000
Chloroethane 10**		0.0002
1,1,1-Trichloroethane 10**		0.0000
Trichloroethylene 0.11	9	0.0000

ERP = Emissions Rate Potential, stated in pounds per hour (lb/hr).
* ERP is based on NYSDEC Air Guide 1 Regulations.
** Actual rate reported is the average for the year.
*** 6 NYCRR Part 212 restricts emissions of VOCs to a maximum of 10 lb/hr without controls.

Cumulative Mass Removal
Average flow rates for each monthly monitoring period were used, in combination with the TVOC concentration in the air-stripper's influent, to calculate the rate of contaminants removed. The cumulative mass of VOCs removed by the treatment system vs. time was then plotted (**Figure 3.1-9**). During 2009, 6.4 pounds of VOCs were removed. Cumulatively, 353 pounds have been removed since 1997. Cumulative mass removal data for this system are summarized on **Table F-4**.

Air Discharge
Table 3.1-4 presents the VOC air emissions data for the year 2009 and compares the values to levels stipulated in NYSDEC Air Guide 1 regulations. Emission rates are calculated through mass balance for water treated during operations. The concentration of each constituent of the air-stripper's influent was averaged for the year. That value was converted from µg/L to pounds per gallon (lb/gal), which was multiplied by the average pumping rate (gal/hr) to compare with the

regulatory value. The VOC air emissions were well below allowable levels.

Recharge Basin

There are nine sentinel monitoring wells in the immediate area surrounding the RA V recharge basin (**Figure 1-2**). These wells are used to monitor water quality and water levels to assess the impact of the recharge basin on the aquifer. **Appendix C** contains the data for these monitoring wells. During 2009 the highest detection of tritium was 753 pCi/L in well 076-173. Beginning November 2001, the RA V recharge basin began receiving treated groundwater from the OU III South Boundary and Middle Road treatment systems. The OU III South Boundary SPDES equivalency permit was modified to include the Middle Road Treatment System and their outfalls at the OU III and RA V recharge basins. The RA V basin resumed receiving water from the HFBR Tritium Pump and Recharge Wells in December 2007.

3.1.8 System Evaluation

The pump and treat system continued to maintain hydraulic control of contaminants originating from the Current Landfill and former HWMF, and to prevent further contaminant migration across the site's southern boundary. No SPDES or air equivalency permit limits have been exceeded, and no operating difficulties were experienced beyond normal maintenance. There have been no problems and no observed interference with other BNL operations, such as the recharge to Basin HO or the OU III South Boundary Pump and Treat System. Pulse pumping (1 month on, 1 month off) of the system was implemented beginning in September 2005, per recommendations in the *2004 Groundwater Status Report* (BNL 2005c). Pulse pumping was discontinued in July 2007.

The OU I South Boundary Pump and Treat system performance can be evaluated based on the five major decisions identified by applying the Data Quality Objectives (DQO) process.

1. Was the BNL Groundwater Contingency Plan triggered?

No. There were no unusual or unexpected concentrations of contaminants observed in monitoring or extraction wells associated with the OU I South Boundary Pump and Treat System during 2009.

2. Has the plume been controlled?

Yes. An analysis of the plume perimeter and bypass wells reveals no significant increases in VOC concentrations in perimeter and bypass monitoring wells during 2009; thus, the VOC plume has not grown and continues to be controlled. **Figure 3.1-1** illustrates that the plume has been effectively cut off at the south boundary and there is separation with the off-site segment of the plume.

The groundwater contour maps are used to evaluate the capture zones of the OU I South Boundary Pump and Treat System (**Figures 2-2** and **2-3**). The capture zone for the OU I South Boundary Pump and Treat System is indicated on **Figure 3.0-1**. The capture zone depicted includes the 50 µg/L TVOC isocontour that is the capture goal of this system.

The area of elevated Sr-90 contamination has migrated approximately 200 to 250 feet south of well 107-35 which is about 800 feet north of the extraction wells at the site boundary.

The groundwater model was updated based on the fourth quarter 2009 monitoring well and 2009/2010 temporary well Sr-90 data. The model predicts that based on the current peak concentration of 29 pCi/L, Sr-90 will not migrate off-site at concentrations above the DWS of 8 pCi/L. The model assumed that EW-1 and EW-2 will run until 2015 and the simulation predicted that Sr-90 decays to below the DWS by 2022.

3. Is the system operating as planned? Specifically, is the aquifer being restored at the planned rate for this treatment system?

Recent groundwater modeling indicates that based on current plume concentrations the cleanup goal will not be met if the system is shutdown at the end of 2011 as currently planned due to the slower than anticipated migration of the higher concentration segment of VOCs through the Upton Unit in the southern portion of the site. The cleanup goals can be achieved by extending the operation of the extraction wells until 2015. These options are currently being evaluated.

4. Can the groundwater treatment system be shut down?
No, the system has not met all shutdown requirements (see below).

4a. Have asymptotic TVOC concentrations been reached in core wells?
Asymptotic conditions are demonstrated by analyzing the average trends in TVOC concentrations in the plume core wells. Asymptotic conditions have not yet been achieved. Aquifer cleanup continues to be demonstrated based on the continued decreasing slope to the trend of average TVOC concentrations in plume core wells, as shown on **Figure 3.1.10**. Changes in the distribution of the plume are shown on **Figure 3.1-11**, which compares the TVOC plume from 1997 to 2009.

4b. Is the mean TVOC concentration in core wells less than 50 µg/L?
Yes, the mean TVOC concentration is currently less than 50 µg/L (**Figure 3.1-10**).

4c. How many individual plume core wells are above 50 µg/L?
Monitoring well 107-40, is the only plume core well to have TVOC concentrations exceeding 50 µg/L. TVOC concentrations are currently stable in this well.

4d. During pulsed operation of the system, is there significant concentration rebound in core wells?
No. Pulsing of the OU I South Boundary System that began in September 2005 was suspended in July 2007 to allow the plume hot spot detected in well 107-40 to migrate south to the extraction wells. There is no benefit in pulse pumping until the remainder of the high concentration segment of the plume has been captured and treated.

5. Have the groundwater cleanup goals been met? Specifically, have MCLs been achieved (expected by 2030)?
No. MCLs have not been achieved for individual VOCs in plume core wells. Updated groundwater modeling predicts that MCLs will not be achieved under the currently planned operation schedule.

3.1.9 Recommendations

The following are recommendations for the OU I South Boundary Pump and Treat System and groundwater monitoring program:

- Install a permanent well approximately 75 feet north of EW-1 and EW-2. Data from this well will be used to determine when the higher concentration segment of the plume has been completely captured.
- Based on data from the new monitoring well (above recommendation), evaluate increasing the operational duration of EW-1 and EW-2 to ensure meeting the cleanup goal for this project.
- Install two new sentinel wells approximately 200 feet south of the Princeton Avenue firebreak road to monitor for the leading edge of the Sr-90 plume.

3.2 OPERABLE UNIT III

There were several VOC, Sr-90, and tritium plumes addressed under the OU III Remedial Investigation/Feasibility Study (RI/FS). The VOC plumes originated from a variety of sources, including Building 96, various small sources in the north-central developed portion of the site, the Former Landfill, OU IV, and the former carbon tetrachloride underground storage tank (UST). **Figure 3.2-1** is a representation of the plumes using TVOC concentrations. The eastern portion of **Figure 3.2-1** also includes the OU IV plume and the North Street (OU I/IV) plumes. **Figure 3.2-2** is cross-section B–B′, which is drawn through the north–south center-line of the primary OU III VOC plumes, as shown in **Figure 3.2-1**.

The primary chemical contaminants found in OU III groundwater are TCA, tetrachloroethylene (PCE), and carbon tetrachloride. These three chemicals are the primary VOCs detected in the OU III on-site monitoring wells. Off site, carbon tetrachloride and PCE are the main contaminants detected.

Figure 3.2-3 presents a comparison of the OU III plumes between 1997 and 2009. Several changes in the plumes can be observed in this comparison:

- The extent of the higher concentration segments of the plumes both on and off-site has decreased over the 12-year period. This is due primarily to the groundwater remediation that has been implemented, along with the affects of natural attenuation.
- Hydraulic control of the plumes by the OU III South Boundary Treatment System at the site boundary and the LIPA system is evidenced by the break in the plumes in these areas.
- Concentrations have been significantly reduced in the vicinity of the Industrial Park East System.
- The attenuation of the on-site portion of the North Street VOC plume.

Three radiological plumes were addressed under Operable Unit III. The HFBR tritium plume extends several thousand feet south from the HFBR spent fuel pool. The downgradient, higher concentration slug is presently being captured by EW-16. Sr-90 plumes are present downgradient of the former WCF and several sources related to the BGRR. A Sr-90 plume is also present downgradient of the Chemical/Glass Holes and Animal Pits area.

Sections 3.2.1 through **3.2.17** summarize and evaluate the groundwater monitoring and system operations data for the OU III VOC and radiological plumes, including both operational groundwater treatment systems and the monitoring-only programs.

This page intentionally left blank.

3.2.1 Former Carbon Tetrachloride Pump and Treat System

This section summarizes the data from the OU III Carbon Tetrachloride Pump and Treat System and offers conclusions and recommendations for monitoring. This system began operating in October 1999, and was formally shut down and placed in standby mode in August 2004 after receiving regulatory approval of the petition for shutdown. Groundwater monitoring has continued and a Petition for Closure of the system was submitted to the regulators in August 2009. Comments were received and the document was revised to incorporate these comments. Final regulatory approval for decommissioning was received in October 2009. Plans are currently under way for system removal and abandonment of the extraction wells and 15 monitoring wells.

This plume originated from a former 1000-gallon UST that had been used to store carbon tetrachloride. The tank was removed in 1998 and several gallons of carbon tetrachloride were released to the groundwater during this removal.

3.2.1.1 System Description

A complete description of the pump and treat system is contained in the *Carbon Tetrachloride Groundwater Removal Action Operations and Maintenance Manual* (BNL 2000a).

3.2.1.2 Groundwater Monitoring

Well Network

A network of 32 wells was designed to monitor the extent of the plume and the effectiveness of remediation.

Sampling Frequency and Analysis

The wells are sampled semiannually, and samples are analyzed for VOCs (**Table 1-5**).

3.2.1.3 Monitoring Well Results

Carbon tetrachloride is the primary contaminant in this plume, but there are also low levels of chloroform (a breakdown compound of carbon tetrachloride). The plume originally extended from the former UST southeast to the vicinity of Weaver Drive, a distance of approximately 1,300 feet (**Figure 3.2.1-1**). However, the plume as defined by the 5 µg/L carbon tetrachloride isocontour now starts just to the southeast of the Chilled Water Building 600 and all concentrations are close to the standard of 5 µg/L. The source area near the former carbon tetrachloride tank no longer has groundwater concentrations of carbon tetrachloride above the NYS AWQS of 5 µg/L. The complete 2009 analytical results from the monitoring of wells in the carbon tetrachloride program are provided in **Appendix C**. A summary of key monitoring well data for 2009 follows.

Figure 3.2.1-2 shows a plot of key monitoring wells associated with this project. As of October 2009 all wells are at or near the NYS AWQS for carbon tetrachloride. The plume will continue to be monitored until NYS AWQS are achieved in all monitoring wells associated with this project. Fifteen of the monitoring wells are being abandoned in 2010 as per recommendations in the petition for closure. These are wells: 085-07, 086-16, 085-160, 085-161, 085-238, 095-183, 095-185, 095-186, 095-296, 095-301095-43, 095-45, 095-47, 095-88, 095-89, and the three extraction wells for this system will also be abandoned (085-158, 085-159 and 095-278). This data is also shown in the Table below (**Table 3.2.1-1**) and on **Figure 3.2.1-3**

Table 3.2.1-1 Summary of Well Data OU III Carbon Tetrachoride

Well ID	Well Type	Depth	CCL4 Conc (ppb)*	Well Status	Rationale
085-07	Plume Core	140-145	<0.5	Abandon	Historically (Since 1997) Been below NYS AWQS
085-13	Plume Core*	250-255	<0.5	Maintain	Magothy well for Water Levels
085-16	Plume Core	34-54	0.76	Abandon	Below NYS AWQS Other wells nearby
085-160	Plume Core	34-54	0.5	Abandon	Below NYS AWQS
085-161	Plume Core	33-53	1.3	Abandon	Below NYS AWQS
085-162	Plume Core	29-49	2.1	Maintain	Low levels CCL_4 present (in 2008)
085-163	Plume Core	29-49	1	Maintain	Low levels CCL_4 present (in 2008)
085-17	Plume Core	34-54	13	Maintain	Low levels CCL_4 present
085-236	Plume Core	35-50	1.6	Maintain	Low levels CCL_4 present (in 2008)
085-237	Plume Core	35-50	3.3	Maintain	Low levels CCL_4 present (in 2008)
085-238	Plume Perimeter	25-45	<0.5	Abandon	Below NYS AWQS
085-98	Plume Core	39-49	2.8	Maintain	Low levels CCL_4 present (in 2008)
095-183	Plume Core	29-49	<0.5	Abandon	Below NYS AWQS
095-185	Plume Core	32-62	0.92	Abandon	Below NYS AWQS
095-186	Plume Perimeter	30-60	2.8	Abandon	Below NYS AWQS
095-277	Plume Core	47-57	2.9	Maintain	Low levels CCL_4 present (in 2008)
095-279	Plume Core	70-80	2.9	Maintain	Low levels CCL_4 present (in 2008)
095-280	Sentinel	85-95	1.4	Maintain	Low Levels CCL_4 present
095-296	Plume Perimeter	60-70	<0.5	Abandon	Below NYS AWQS
095-300	Plume Perimeter	70-80	4.4	Maintain	Low levels CCL_4 present (in 2008)
095-301	Plume Core	70-80	<0.5	Abandon	Below NYS AWQS
095-42	Sentinel	100-105	<0.5	Maintain	Middle Road Monitoring
095-43	Plume Core	108-113	<0.5	Abandon	Below NYS AWQS
095-45	Plume Core	108-113	<0.5	Abandon	Below NYS AWQS
095-47	Plume Core	195-200	<0.5	Abandon	Below NYS AWQS
095-53	Sentinel*	87-92	1.6	Maintain	Low levels CCL_4 present
095-88	Plume Core	155-160	<0.5	Abandon	Below NYS AWQS
095-89	Plume Core	155-160	<0.5	Abandon	Below NYS AWQS
095-90	Sentinel*	98.5-108.5	12	Maintain	Low levels CCL_4 present
095-92	Sentinel	116-126	<0.5	Maintain	Middle Road Monitoring
104-11	Sentinel (Middle Rd. Tracking)	185-195	<0.5	Maintain	Well used in Middle Road Program
104-36	Sentinel (Middle Rd. Tracking)	126-146	11	Maintain	Well used in Middle Road Program
105-23	Sentinel*	175-185	11	Maintain	Well used in Middle Road Program
105-42	Sentinel (Middle Rd. Tracking)	145-150	<0.5	Maintain	Well used in Middle Road Program
085-158	OU III (Carbon tet) EW-13	32-52	<0.5	Abandon	Extraction well Less then NYS AWQS
085-159	OU III (Carbon tet) EW-14	32-52	1.2	Abandon	Extraction well Less then NYS AWQS
095-278	OU III (Carbon tet) EW-15	65-85	1.2	Abandon	Extraction well Less then NYS AWQS

*Concentration is the most recent sample available in June 2009 generally from the first quarter 2009.

3.2.1.4 System Operations

Operating Parameters

In 2009, the extraction wells were sampled quarterly. These samples are analyzed for VOCs. The extraction well data are located on **Table F-5**. The parameters for sampling pH and VOCs adhere to the requirements of the SPDES equivalency permit. However, the system was in standby in 2009 and in October approval for system decommissioning was received from the regulatory agencies. The system operations are summarized below.

January – December 2009

The system was in standby mode during this period. Sampling for the SPDES equivalency permit was not performed since the system was shutdown.

3.2.1.5 System Operational Data

The system was shut down for the entire year so only quarterly sample data were collected from the extraction wells. All samples collected from the extraction wells in 2009 showed concentrations below the NYS AWQS of 5 µg/L for carbon tetrachloride.

3.2.1.6 System Evaluation

The system was placed in a standby mode in August 2004 after approval of the petition for shutdown. The system remained in standby mode for all of 2006, 2007, 2008 and 2009.

The Carbon Tetrachloride Pump and Treat System performance can be evaluated based on the five major decision rules identified by applying the DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?

No. There were no detections of either carbon tetrachloride or any other contaminants in wells associated with this monitoring network during 2009 that would have triggered the BNL Groundwater Contingency Plan.

2. Were the cleanup goals met?

Yes. The groundwater cleanup goals for the system have been met. The system was shut down in August 2004. A petition to close the system was approved in October 2009.

3. Has the plume been controlled?

Yes. The plume has been controlled, and the system will be decommissioned in 2010.

4. Is the system operating as planned?

Not applicable

3.2.1.7 Recommendations

The following is the recommendation for the OU III Carbon Tetrachloride Groundwater Remediation System and monitoring program:

- Continue monitoring the remaining groundwater monitoring wells until NYS AWQS are achieved.

This page intentionally left blank

3.2.2 Building 96 Air Stripping System

This section summarizes the 2009 operational data from the OU III Building 96 Treatment System, which consists of three recirculation wells and one pumping well with air stripping and vapor-phase carbon treatment. It also presents conclusions and recommendations for future operation of the system. The system began operation in February 2001. All treatment wells, RTW-1 through RTW-4 operated full time during 2009. For a history of the operation of these wells over the last nine years, refer to previous Groundwater Status Reports.

3.2.2.1 System Description

Contaminated groundwater is drawn from the aquifer via a submersible well pump in a lower well screen, 48 to 58 feet bls, near the base of the contaminant plume. The groundwater then is pumped into a stripping tray adjacent to each of the four wells. After treatment the clean water is recharged back to the shallow portion of the plume through the upper screen, 25 to 35 feet bls. In May 2008, well RTW-1 was modified from a recirculation well to a pumping well with hexavalent chromium ion exchange treatment, and discharge to the nearby surface drainage culvert. This well also continues to use air stripping for the treatment of VOC's.

The contaminated air stream from the air stripper from the four treatment wells is routed to a treatment and control building, where it is passed through two vapor-phase granular activated carbon (GAC) units in series to remove the VOCs. Treated air is then discharged to the atmosphere. A complete description of the system is included in the *Operations and Maintenance Manual Building 96 Groundwater Treatment System* (BNL June 2009- Rev.1).

3.2.2.2 Source Area Characterization and Selected Remedy

In 2008, detailed soil characterization and soil vapor testing identified high PCE concentrations in the unsaturated zone from just below land surface to a depth of approximately 15 feet bls. This area of approximately 25 by 25 feet is just south of former Building 96. Maximum PCE concentrations detected in the soil were 1,800 milligrams per kilogram (mg/kg) at approximately 9 feet bls. A summary of the characterization is provided in the 2008 Groundwater Status Report. **Figure 3.2.2-1** shows the location of the PCE source area soil contamination in relation to the 2009 VOC groundwater plume.

In November 2008, as a temporary measure to minimize infiltration from precipitation, a plastic liner was installed over the soil contamination area. This liner was upgraded in July 2009.

To optimize the effectiveness of the Building 96 groundwater remedy, in December 2008 BNL recommended excavation of contaminated soils with off-site disposal. This is in addition to the continued operation of the groundwater treatment system until the capture goal is attained, which is expected within three to six years of the soil excavation (by 2016). Optimization of the remedy by reducing the number of years of treatment will enable BNL to achieve the cleanup goal of the ROD for this groundwater plume (i.e., meeting drinking water standards by 2030). The regulatory approach for this action was to document the change in an Explanation of Significant Differences (ESD) to the OU III ROD. Following review and approval by the regulators, the *Final Operable Unit III Explanation of Significant Differences for Building 96 Remediation* (BNL September 2009) was issued.

As shown on **Table 2-4**, since the second half of 2009 the water table throughout the site has risen dramatically due to above normal precipitation. As a result, the water table immediately below the contaminated source area has risen approximately four feet since January 2010. A cross-section of the soil contamination area in relation to the water table as of April 2010 is shown on **Figure 3.2.2-2.** An extended cross section of the Building 96 area is shown on **Figure 3.2.2-4.** Consequently, the water table is currently approaching the bottom of the planned soil excavation area.

Excavation of the source area is expected to be performed in the summer/fall of 2010. Based on seasonable water table fluctuations, the water table would be lower at this time of the year.

3.2.2.3 Groundwater Monitoring

A network of 34 wells is used to monitor the VOC plume and the effectiveness of the Building 96 groundwater remediation system (**Figure 1-2**). Well 095-312 (formerly B96-MW2009) was installed in March of 2009. The majority of the wells are sampled quarterly and analyzed for VOCs in accordance with **Table 1-5**. As noted in the recommendations in the 2008 Groundwater Status Report, the sampling frequency for several wells was reduced. In addition, since 2008, all wells are sampled quarterly for chromium (Cr) and hexavalent chromium (Cr [VI]).

3.2.2.4 Monitoring Well Results

Complete VOC results are provided in **Appendix C**. The fourth quarter 2009 plume is shown on **Figure 3.2.2-1**. A summary of key monitoring well data for 2009 follows.

- The highest TVOC concentration seen in 2009 was 7,344 μg/L in groundwater from core well 085-353 during the first quarter sampling round. The primary contaminant is PCE, with a value of 7,300 μg/L. Well 085-353 is located in the center of the soil contamination source area identified in **Section 3.2.2.2.** As shown in trend **Figure 3.2.2-3**, this well has historically contained significant contamination, with TVOC levels never lower than 600 μg/L. However in October 2009, well 085-353 TVOC concentrations dropped significantly to 79 μg/L. These drastic fluctuations are related to the rise and fall of the water table in relation to the location of the well screen. As shown on trend **Figure 3.2.2-3**, plume core monitoring wells 085-347, 085-353, and 095-84 continue to show significant rebounding of contaminant levels over the last several years.

- TVOC concentrations in plume core well 085-352 (screened in the silt zone in the eastern portion of the plume) continued rebounding since 2007 (up to 1,409 μg/L in October 2009) after two years of lower concentrations from mid 2005 through 2006 (maximum of 110 μg/L in May 2006). Conversely, TVOC concentrations in plume core well 095-306, located in the western portion of the plume, have been gradually increasing since 2008, to a high of 2,283 μg/L in July 2009. This contamination will be captured by RTW-1.

- Plume core wells 095-162 and 095-172 (located between treatment well RTW-1 and downgradient recirculation wells RTW-2 through RTW-4) began showing increasing TVOC concentrations from 2006 through 2008 after several years of concentrations below 50 μg/L. This is due to the plume passing by RTW-1 while it was in standby mode from June 2006 through May 2008. In 2008, maximum TVOC concentrations in these wells were 510 μg/L and 652 μg/L, respectively. However, well 095-162 dropped below 5.0 μg/L TVOCs in January 2009, indicating effective capture of the contaminants by RTW-1. TVOCs in 2009 in well 095-172 ranged between 121 μg/L in January to 25 μg/L in July. This well is approximately 80 feet downgradient of 095-162.

- Plume core well 095-159 also began increasing since 2006 to 319 μg/L TVOCs in July 2009, its highest level since 2001. This well is the same distance downstream of RTW-1 as 095-162, but further to the west. This contamination will be captured by the downgradient recirculation treatment wells.

- The bypass monitoring wells immediately downgradient of extraction wells RTW-2, RTW-3, and RTW-4 generally showed reduced TVOCs since 2007. The reduced concentrations are consistent with the downgradient extraction wells being placed back in service in late 2007 and early 2008. In 2009, TVOC concentrations in the bypass wells were below 5.0 μg/L.

- As a follow-up to a concern raised by SCDHS, in March and April of 2010, three temporary wells (Bldg96-GP-01, Bldg96-GP-02, and Bldg96-GP-23) were installed along Weaver Drive to determine if hexavalent chromium has migrated downgradient to this area and to characterize the concentration of PCE at this location. The highest hexavalent chromium and TVOCs detected from these wells were 12 µg/L and 98 µg/L, respectively . The data are presented in **Tables 3.2.2-1 and 3.2.2-2.**

- One of the 34 monitoring wells, 095-172, detected hexavalent chromium above the SPDES discharge limit of 100 µg/L with a value of 196 µg/L in January 2009. In 2008, seven monitoring wells exceeded 100 µg/L. The hexavalent chromium monitoring well data for 2009 is posted on **Figure 3.2.2-5.**

3.2.2.5 System Operations

Operating Parameters

All treatment wells, RTW-1 through RTW-4 operated full time during 2009.

Table 3.2.2-3
OU III Building 96 RTW-1 Pump & Treat Well
2009 SPDES Equivalency Permit Levels

Parameter	Permit Level (µg/L)	Max. Measured Value (µg/L)
pH range	5.0–8.5 SU	6.2–7.5 SU
chromium (hexavalent)	100	24
tetrachloroethylene	5.0	16
1,1,1-trichloroethane 5.0		<0.5
Thallium Mon	itor	1.7

Note:Required effluent sampling frequency is monthly following a period of 24 consecutive weekly with no exceedances. Weekly for pH.

January – September 2009

During this period the system operated normally for the majority of the time. There were short periods during these months that the system or individual wells were off for a couple of days. The system was off part of the month in April due to electrical problems. In July, the well drilling contractor re-graded and put a new poly liner over the Building 96 proposed soil excavation area. From January through September, approximately 38 million gallons of water were pumped (Table F-8).

October – December 2009

The system was down for about a week in December due to electrical problems. All wells operated normally for the remainder of this period. The groundwater treatment system pumped and treated approximately 12 million gallons of water in the fourth quarter of 2009.

During 2009, the groundwater treatment system pumped and treated a total of approximately 50 million gallons of water (Table F-8).

3.2.2.6 System Operational Data

Recirculation/Treatment Well Influent and Effluent

Table F-6 lists the quarterly influent and effluent TVOC concentrations for the three recirculation wells and treatment well RTW-1. The highest TVOC concentration from the influent of these wells was 112 µg/L in RTW-1 in the first quarter. The maximum TVOC in the influent of the downgradient wells was 11 µg/L in RTW-3 in January 2009. RTW-2 and RTW-4 influent showed a maximum of 3 µg/L and 0.5 µg/L TVOCs in 2009, respectively. **Figure 3.2.2-6** shows the TVOC concentrations in the treatment wells over time. **Table 3.2.2-3** shows the maximum measured effluent contaminant concentrations compared to the equivalency permit for well RTW-1. The system met all equivalency parameters for operation except for PCE at 16 µg/L on the June 8, 2009 effluent sample from RTW-1. There were five sampling events in June on the 3rd, 8th, 18th, 22nd and 30th and all of the events (with the exception of June 8th) showed concentrations below the detection limit of 0.5 µg/L. The influent concentrations were similar on all of the events and the removal efficiency has always been greater then 99% for this system. It is believed that there was some contamination introduced into the June 8th sample based upon the sampling data before and after this event. A NYSDEC *Report of Noncompliance Event* form was submitted to the regulators.

The maximum hexavalent chromium detection in the influent to RTW-1 in 2009 was 32 µg/L, approximately one third of the SPDES discharge standard. The maximum discharge level detected in the effluent in this well for the year was 24 µg/L. Since the second quarter of 2009, RTW-1 influent and the adjacent monitoring wells were below 100 µg/L of hexavalent chromium. The regulators were briefed during an IAG teleconference on October 29, 2009 on the status of the monitoring for the hexavalent chromium and BNL's intent to remove the resin treatment. In January 2010, the resin treatment was bypassed and placed in standby mode.

Air Treatment System

In 2009, quarterly air sampling was performed from the GAC vessels before treatment (influent), between the two vessels (midpoint), and after the second vessel (effluent). The analytical data are available on **Table F-7**, and the VOC emission rates are summarized on **Table 3.2.2-4.** The findings are utilized to monitor the efficiency of the GAC units and to determine when a carbon change-out is required. Airflow rates, measured for each air-stripping unit inside the treatment building, show that they typically range between 250 and 450 cubic feet per minute (cfm) for each of the four wells. Assuming a total airflow rate of 1,200 cfm, all compounds detected in the carbon effluent during the operating year were much lower than the New York State DAR-1 Air Toxics Assessment limits for the worst-case potential impacts to the public.

Table 3.2.2-4
OU III Building 96 Area
2009 Average VOC Emission Rates

Parameter	Allowable ERP* (lb/hr)	Actual** ER (lb/hr)
dichlorodifluoromethane 0.00	00187	0.00000236
acetone 0.00	0674	ND
methylene chloride	0.000749	0.00000103
2-butanone 0.00	0187	ND
benzene 0.00	0112	0.0000138
tetrachloroethylene 0.00	0165	ND
m,p-xylene 0.00	00116	ND
isopropylbenzene 0.00	0243	ND
n-propylbenzene 0.00	00599	ND
1,3,5-trimethylbenzene 0.00	0375	0.0000139
1,2,4-trimethylbenzene 0.00	0225	0.0000271
4-isopropyltoluene 0.00	000749	ND
naphthalene 0.00	00225	ND
carbon disulfide	0.0000487	ND
styrene 0.00	000637	ND
trans-1,3-dichloropropane 0.00	00157	ND

Notes:

ER = Emissions Rate
ERP = Emissions Rate Potential, stated in lb/hr.
* ERP is based on NYSDEC Air Guide 1 Regulations.
** Actual rate reported is the average for the year.
ND = Analyte not detected

Cumulative Mass Removal

Table 3.2.2-5 shows the monthly extraction well pumping rates. The pumping and mass removal data are summarized on **Table F-8**. In 2009, approximately 9 pounds of VOCs were removed. Since February 2001, the system has removed approximately 107 pounds of VOCs.

3.2.2.7 System Evaluation

The OU III Building 96 Treatment System performance can be evaluated based on the five major decisions identified by applying the DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?

No. As a follow-up to the triggering of the Contingency Plan in 2008, the selected remedy for the PCE soil source area was excavation and off-site disposal, with continued groundwater treatment. This remedy was documented in the *Final Operable Unit III Explanation of Significant Differences for Building 96 Remediation, issued in 2009.*

2. Have the source control objectives been met?
No. As a result of the soil boring investigation performed in 2008, a localized continuing source area exists in the vadose zone. Excavation of the source area followed by continued operation of the existing RTW-1 treatment well will allow for the source control objectives to be met. Groundwater modeling performed in late 2008 determined that without excavation of the source area, the overall cleanup goals would not be achieved. Modeling also determined that following some "tailing" effect from the vadose zone source area after it is excavated, well RTW-1 will need to operate for another three to six years (by 2016).

3. Has the plume been controlled?
Yes. Following the modification of extraction well RTW-1 as a pumping well, it has demonstrated effective capture of the plume source area (**Figure 3.2.2-7**). Based on the low concentrations of VOCs in recirculation wells RTW-2, RTW-3, and RTW-4 and the nearby monitoring wells it appears that RTW-1 is effectively capturing the VOCs migrating from the source area.

4. Is the system operating as planned? Specifically, is the aquifer being restored as planned?
No. Although extraction well RTW-1 is effectively capturing the plume and treating high PCE concentrations there remains a continuing source for high concentrations of PCE in shallow soil contaminating groundwater. Significant reduction of PCE in groundwater cannot be achieved without the elimination of the source area.

5. Can the groundwater treatment system be shut down?
No, the system has not met all shutdown requirements.

5a. Is the mean TVOC concentration in core wells less than 50 µg/L?
No. The mean TVOC concentration in the core wells was 580 µg/L during the fourth quarter 2009.

5b. How many individual plume core wells are above 50 µg/L TVOCs?
TVOC concentrations in 15 of 21 core wells were above 50 µg/L in 2009.

5c. Have the groundwater cleanup goals been met? Are MCLs expected to be achieved by 2030?
MCLs have not been achieved for individual VOCs in all plume core wells. However, following soil excavation and between three to six more years of treatment system operation (by 2016), MCLs are expected to be achieved by 2030.

3.2.2.8 Recommendations

The following are recommendations for the OU III Building 96 Groundwater Remediation System and monitoring program:

- Maintain full time operation of treatment well RTW-1.
- Install temporary wells upgradient of recirculation wells RTW-2, RTW-3, and RTW-4. If TVOCs in these wells and the recirculation wells are below 50 µg/L, then wells RTW-2, RTW-3, and RTW-4 will be placed in standby mode. Maintain a monthly sampling frequency of the influent and effluent for each well.
- Maintain integrity of the plastic liner covering the PCE-contaminated soils. Excavate the source area in the summer/fall of 2010. This also involves the removal of monitoring well 085-353 located in the center of the proposed excavation area. Following excavation, three additional

monitoring wells will be installed to monitor the effectiveness of the contaminated soil removal, including a replacement for well 085-353.

- Continue to analyze for total chromium and hexavalent chromium in the monitoring wells quarterly, and in the effluent to RTW-1 two times per month.
- Continue to maintain the resin treatment in standby mode, and if concentrations of hexavalent chromium increase to over 50 ug/L in RTW-1, treatment would resume.
- Based on the results of the data from the three temporary wells installed along Weaver Drive, a permanent well will be installed.

3.2.3 Middle Road Pump and Treat System

The Middle Road Groundwater Pump and Treat System began operating in October 2001. This section summarizes the operational data from the Middle Road system for 2009, and presents conclusions and recommendations for future operation. The analytical data from the monitoring wells are also evaluated in detail.

3.2.3.1 System Description

The Middle Road system was designed with six extraction wells and air-stripping technology to remove VOCs from the groundwater. In September 2003, extraction wells RW-4 and RW-5 were placed in standby mode due to low concentrations of TVOCs. In September 2006, well RW-6 was also placed in standby mode due to low TVOC concentrations. The system is currently operating utilizing wells RW-1, RW-2 and RW-3 at a pumping rate of approximately 500 gpm. A complete description of the system is included in the *Operation and Maintenance Manual for the OU III Middle Road and South Boundary Groundwater Treatment Systems, Revision 1* (BNL 2003a).

3.2.3.2 Groundwater Monitoring

The Middle Road Monitoring Program consists of a network of 29 monitoring wells located between the Princeton Avenue firebreak road and the OU III South Boundary Pump and Treat System (**Figure 1-2**). Four new monitoring wells were added in 2008: one upgradient of well RW-1 (MW 105-66), one approximately 100 feet to the west of well 113-09 (113-29), and two upgradient wells, located just south of Princeton Avenue (104-37 and 104-38). A temporary well was installed in April 2009 just west of RW-1 (MRVP-09). The data is shown on **Figure 3.2.3-2**. This was installed to evaluate the western extent of the VOC plume in this area. Based upon the depth and high concentrations of PCE in this temporary well a larger pump was installed in extraction well RW-2 to increase the capture zone of this well. A pump test was performed in September 2009 to evaluate the capture zone. A discussion of the aquifer test results is included below in **Section 3.2.3.5**.

The 29 Middle Road wells are sampled and analyzed for VOCs. Nine of the wells are sampled quarterly, and the remainder are sampled semiannually (**Table 1-5**).

3.2.3.3 Monitoring Well Results

The complete VOC results are provided in **Appendix C**. The highest plume concentrations are found between extraction wells RW-1 and RW-3, based on influent data for these wells and monitoring well data (**Figure 3.2.3-1**). TVOC concentrations in monitoring wells east of RW-3 are generally below 10 µg/L. TVOC concentrations have generally been stable in 2009. Results for key monitoring wells are as follow:

- The highest TVOC concentration detected (449µg/L) was in bypass detection well 113-11 in October 2009. The VOCs in this bypass well were present prior to the operation of the pump and treat system, and are expected to be captured by the OU III South Boundary system.
- Bypass well 113-17 has shown a significant decrease in TVOCs since 2005, with concentrations dropping from 1,347 µg/L to less than 200 µg/L in 2009.
- Plume core well 105-23 is approximately 2,000 feet upgradient of RW-1, near Princeton Avenue. TVOC concentrations have decreased from 1,794 µg/L during 2001, to 59 µg/L in the fourth quarter of 2009 (**Figure 3.2.3-3)**.
- TVOC concentrations in plume core wells to the east of well 105-23, along Princeton Avenue, were below 100 µg/L in 2009 except for well 104-37. Well 104-37 saw a significant increase from 116 to 432 µg/L. The primary contaminants observed in this well was carbon tetrachloride at 200 and PCE at 210 µg/L. TVOC concentrations decreased in well 105-44, from 423 µg/L in 2001 to 6 µg/L in the fourth quarter of 2009, (See **Figure 3.2.3-3)**.

- New monitoring well 113-29, located west of RW-1, showed TVOC concentrations of 23 µg/L in 2009. This well is a perimeter monitoring well for the Middle Road System. This is below the capture goal for the treatment system of 50 µg/L
- New monitoring well 105-66, installed upgradient of extraction wells RW-1 and RW-2, showed TVOC concentrations of 273 µg/L in 2009. This is a core well installed in 2008 to monitor levels of VOCs migrating to these extraction wells. Concentrations have been stable in this well. This well is sampled on a quarterly basis.

Table 3.2.3-1.
OU III Middle Road Air Stripping Tower
2009 SPDES Equivalency Permit Levels

Parameters	Permit Limit	Max. Observed Value
pH range (SU)	6.5–8.5	6.9 – 7.5
carbon tetrachloride	5 µg/L	ND
chloroform 7	µg/L	ND
dichlorodifluoromethane 5	µg/L	ND
1,1-dichloroethane 5	µg/L	ND
1,1-dichloroethylene 5	µg/L	ND
methyl chloride	5 µg/L	ND
tetrachloroethylene 5	µg/L	ND
toluene 5	µg/L	ND
1,1,1-trichloroethane	5 µg/L	ND
1,1,2-trichloroethane 5	µg/L	ND
trichloroethylene 10	µg/L	ND

Notes:
ND = Not detected above method detection limit of 0.50 µg/L.
SU = Standard Units
Required sampling frequency is monthly for VOCs and pH.

Figure 3.2.3-2 shows the vertical distribution of contamination running along an east–west line through the extraction wells; the location of this cross section (E–E') is given on **Figure 3.2-1**. VOC contamination in the western portion of the remediation area (RW-1 through RW-3) extends into the upper Magothy aquifer, as does the screen on well RW-3. This figure shows that the area of TVOCs exceeding the capture goal of 50 µg/L is limited to the western portion of the treatment system in the vicinity of RW-1, RW-2 and RW-3. The data shows that the highest concentrations are in the vicinity of RW-1 but at the depth correlating with the screen interval of RW-2 located approximately 150 feet east of MRVP-09. Due to these findings a larger pump was installed in RW-2 capable of increasing the flow rate from 170 gpm to about 300 gpm. After this installation, a pumping test was performed on this well with a pumping rate of 300 gpm, from September 10, 2009 until September 17, 2009. The complete aquifer test report (JR Holzmacher P.E., LLC January, 2010) is included in Appendix H.

In summary the report concluded that with the increases pumping rate in well RW-2 to 300 gpm the estimated capture zone includes the portions of the plume that are greater then 50 µg/L. Figure 5 in the report shows the projected capture zone with well 2 operating at 300 gpm.

3.2.3.4 System Operations

The effluent sampling parameters for pH and VOCs follow the requirements for monthly sampling, as per the SPDES equivalency permit (**Table 3.2.3-1**). In addition, system influent samples are analyzed for tritium during each system-sampling event. Tritium remains below detection limits in these samples. The effluent concentrations from the treatment system during this period of operation were below equivalency permit levels.

Approximately 177 million gallons of water were pumped and treated in 2009 by the OU III Middle Road System. The following summarize the Middle Road System operations for 2009.

January – September 2009

The system was off from January to the end of March due to communication problems with the pump house and the blower building. The problem was a buried splice that had failed and could not be excavated until March due to the frozen ground. Approximately 141 million gallons of water were treated.

October – December 2009

The system operated normally in October and November, and pumped and treated approximately 36.5 million gallons of water during this quarter. The system was down sporadically during December to troubleshoot and repair the control system primarily due to electrical problems.

3.2.3.5 System Operational Data

System Influent and Effluent

Figure 3.2.3-5 plots the TVOC concentrations in the extraction wells versus time. Results of the extraction wells samples are found on **Table F-9.** The influent VOC concentrations remained constant over the reporting period. The average TVOC concentration in the influent during 2009 was 41 µg/L. The results of the influent and effluent sampling are summarized on **Tables F-10** and **F-11**, respectively.

Cumulative Mass Removal

Mass balance was calculated for the period of operation to determine the mass removed from the aquifer by the pumping wells. Average flow rates for each monthly monitoring period were used, in combination with the TVOC concentration in the air-stripper influent, to determine the pounds removed. Flow averaged 337 gpm during 2009 (**Table 2-3**, and **Table F-12)**, and approximately 63 pounds of VOCs were removed. Approximately 862 pounds of VOCs have been removed since the system began operations in October 2001. The cumulative total of VOCs removed vs. time is plotted on **Figure 3.2.3-4**.

Table 3.2.3-2.
OU III Middle Road Air Stripper
2009 Average VOC Emission Rates

Parameter	Allowable ERP* (lb/hr)	Actual** (lb/hr)
carbon tetrachloride	0.022	0.0003
chloroform 0.00	31	0.0001
1,1-dichloroethane 10***		0.000047
1,2-dichloroethane 0.00	8	0.000001
1,1-dichloroethylene 0.03	4	0.0002
cis-1,2-dichloroethylene 10***		0.0002
trans-1,2-dichloroethylene 10***		0
tetrachloroethylene 0.38	7	0.0763
1,1,1-trichloroethane 10***		0.0006
trichloroethylene 0.14	3	0.0003

Notes:

ERP = Emission Rate Potential. Reported in lb/hr.
*ERP based on NYSDEC Air Guide 1 Regulations.
** Rate reported is the average rate for the year.
*** 6 NYCRR Part 212 restricts emissions of VOCs to a maximum of 10 lb/hr without controls.

Air Discharge

Table 3.2.3-2 shows the air emissions data from the system for the OU III Middle Road tower during 2009, and compares the values to levels stipulated in NYSDEC Air Guide 1 regulations. Emission rates are obtained through mass-balance calculations for the water treated during that time (**Table F-10**). The concentration of each constituent was averaged for 2009, and those values were used in determining the emissions rate. The air emissions determined for the Middle Road system were below permitted limits.

Extraction Wells

Extraction wells RW-4 and RW-5 were shut down in September 2003 and placed on standby due to low concentrations of VOCs. The extraction wells are sampled quarterly. RW-6 was shut down in September 2006 due to low VOC concentrations in this well. Quarterly sampling of the wells will continue. The influent VOC concentrations generally remained constant over the reporting period for the extraction wells, with the exception of well RW-5. RW-5 had two detections of TVOC concentrations of 72 µg/L in July and 11 µg/L in August. Then in October concentrations again were 72 µg/L. **Table 3.2.3-3** shows the monthly extraction well pumping rates.

3.2.3.6 System Evaluation

The OU III Middle Road Pump and Treat System performance can be evaluated based on the five major decisions identified for this system from the groundwater DQO process.

1. Was the BNL Contingency Plan triggered?
No. There were no unusual or unexpected VOC concentrations observed in the monitoring wells or extraction wells associated with the OU III Middle Road Pump and Treat System during 2009.

2. Has the plume been controlled?
Yes. TVOC concentrations in plume perimeter wells remained stable at low concentrations during 2009, indicating that the plume is being controlled. High TVOC concentrations in bypass wells were present before the system was operational and are not within the capture zone of the extraction wells. It will take several additional years before the contaminants migrate to the South Boundary System. However these wells have shown a declining trend and some of them are in an area called the stagnation zone where there is little groundwater movement. Semiannual groundwater elevation data were obtained from many of the OU III Middle Road monitoring program wells, in addition to wells located throughout the BNL on-site and off-site monitoring areas. Groundwater contour maps are generated using these data (**Figures 2-2** and **2-3**).

The capture zone for the OU III Middle Road System is depicted on **Figure 3.0-1**. The capture zone encompasses the 50 µg/L contour, which is the capture goal of this system.

3. Is the system operating as planned? Specifically, is the aquifer being restored at the planned rate for this treatment system?
Yes. The system is operating as planned based on the mass removal of VOCs. Monitoring wells show generally steady concentration trends during 2009 (**Figure 3.2.3-3**).

4. Can the groundwater treatment system be shut down?
No, the system has not met all shutdown requirements (see below).

> *4a. Have asymptotic TVOC concentrations been reached in core wells?*
> No. However, monitoring and extraction wells have shown generally decreasing concentration trends since 2002 and these trends have continued.
>
> *4b. Is the mean TVOC concentration in core wells less than 50 µg/L (expected by 2025)?*
> No, the average TVOC concentration for the plume core wells was 48.3 µg/L (**Figure 3.2.3-6**).
>
> *4c. How many individual plume core wells are above 50 µg/L?*
> Six of the 16 plume core wells contain TVOC concentrations greater than 50 µg/L.
>
> *4d. During pulsed operation of the system, is there significant concentration rebound in the core wells?*
> To date, the OU III Middle Road System has not been pulsed.

5. Have the groundwater cleanup goals been met? Have MCLs been achieved (expected by 2030)?
No. MCLs have not been achieved for individual VOCs in all plume core wells. However, MCLs are expected to be achieved by 2030.

3.2.3.7 Recommendations

The following recommendations are made for the OU III Middle Road Pump and Treat System and groundwater monitoring program:

- Maintain the routine operation and maintenance monitoring frequency that is currently in effect.

- Maintain extraction wells RW-4, and RW-6 in standby mode during 2010. Restart well RW-5 and operate until TVOC concentrations drop below 50 µg/L for two consecutive quarterly extraction well sampling events. Restart the wells if extraction or monitoring well data indicate that TVOC concentrations exceed the 50 µg/L capture goal. Maintain a minimum pumping rate of 250 gpm on well RW-2.
- Install one temporary well approximately 300 feet east of monitoring well 104-36 and based upon the results install a monitoring well to monitor the progression of higher upgradient concentrations of TVOCs to the treatment system.
- Install a monitoring well centered on the high concentrations identified in the recent temporary well near well RW-1.

This page intentionally left blank

3.2.4 South Boundary Pump and Treat System

This section summarizes the operational data from the OU III South Boundary Groundwater Pump and Treat System for 2009, and gives conclusions and recommendations for future operation. Also included within this section is an evaluation of the system and extraction well monitoring and sampling data.

3.2.4.1 System Description

This system began operation in June 1997. It utilizes air-stripping technology for treatment of groundwater contaminated with chlorinated solvents. There are seven extraction wells. The system is currently operating at a pumping rate of approximately 350 gpm, utilizing three extraction wells. Extraction wells EW-12 and EW-8 were placed on standby in October 2003 and October 2006, respectively, due to low VOC concentrations. Wells EW-6 and EW-7 were placed in standby mode in November and December 2007, respectively. A complete description of the system is included in the *Operation and Maintenance Manual for the OU III Middle Road and South Boundary Groundwater Treatment Systems, Revision 1* (BNL 2003a).

3.2.4.2 Groundwater Monitoring

The monitoring well network consists of 43 wells and was designed to monitor the VOC plume(s) in this area of the southern site boundary, as well as the efficiency of the groundwater remediation system (**Figure 3.2.4-1**). The South Boundary wells are sampled and analyzed for VOCs at frequencies detailed on **Table 1-5**. A number of OU III South Boundary wells are also analyzed for radionuclides as detailed in **Section 3.2.14**.

3.2.4.3 Monitoring Well Results

The south boundary segment of the OU III VOC plume continued to be bounded by the existing monitoring well network. Perimeter well 121-08 had a TVOC concentration of 18 µg/L in October. Individual VOC concentrations in the remaining plume perimeter wells were less than 5 µg/L in October 2009 (**Figure 3.2.4-1**). This is well below the capture goal of the system of 50 µg/L for TVOC concentrations. VOCs were detected in the deep Upper Glacial aquifer in the vicinity of the site boundary, as depicted on **Figures 3.2-2, 3.2.4-1,** and **3.2.4-2. Appendix C** has the complete groundwater monitoring results for 2009.

The plume core wells continued to show the same trend of decreasing VOC concentrations that were observed following the start-up of the pump and treat system in 1997. The bulk of the VOC contamination in this area is currently located between EW-3 and EW-5, as can be seen on **Figure 3.2.4-2,** which is a cross section (F–F') drawn along the south boundary. The VOC concentration trends for specific key wells are shown on **Figure 3.2.3-3.** Results for key monitoring wells are as follow:

- Plume core well 122-22 is immediately east of EW-8. A sharp drop in TVOC concentrations was observed during 1997 and 1998 from its pre start-up concentration of 1,617 µg/L. VOC concentrations have remained very low, with only PCE being detected at 11µg/L in April 2009. However in the next sampling event in October concentrations had dropped to 2.3 µg/L.
- Plume core well 122-19 is directly downgradient of EW-8. Plume core well 122-04 is located between EW-7 and EW-8. Plume core well 114-07 is immediately upgradient of EW-12. VOCs have not been detected above standards during 2009 in these wells.
- Plume core well 121-23 is immediately downgradient of EW-5. During 2009, the TVOC concentrations ranged between 15 µg/L and 7 µg/L (In April and October). This is a decrease from concentrations observed last year in this well when concentrations were 30 µg/L to 40 µg/L.
- Monitoring well 121-45 was installed in 2006 to monitor the higher VOC concentrations present at wells 113-17 and 113-11. This well is located between the Middle Road and South Boundary

systems. The 2009 results showed TVOC concentrations as high as 374 µg/L during January but had declined to 215 µg/L by October **(Figure 3.2.4-1)**.

- Plume core well 121-11 is upgradient of EW-3. TVOC concentrations ranged from 26 µg/L in November 2009 to 3 µg/L in April 2009.
- Plume core well 122-05 is a Magothy monitoring well west of EW-8. TVOC concentrations have been showing a stable trend with a concentration of 32 µg/L in November 2009 **(Figure 3.2.4-1)**.
- Bypass Detection Well 121-43 located several hundred feet south of extraction well 4 has consistently shown elevated levels of VOCs. The TVOC concentration in this well was 160 µg/L in November 2009. This may be contamination that is trapped in the stagnation zone downgradient of EW-4.

3.2.4.4 System Operations

The individual extraction wells are sampled quarterly and analyzed for VOCs. The effluent sampling parameters of pH and VOCs are done monthly, in accordance with SPDES equivalency permit requirements (**Table 3.2.4-1**). In addition, samples are analyzed for tritium with each system-sampling event. In these samples, tritium continues to remain below analytical reporting limits. Effluent VOC concentrations from the treatment system during this period of operation were below equivalency permit requirements.

System Operations

In 2009, approximately 201 million gallons of water were pumped and treated by the OU III South Boundary System. Well EW-8 was put in standby mode in October 2006, and EW-12 has remained in standby since 2003. Wells EW-6 and EW-7 were put on standby near the end of 2007.

Table 3.2.4-1.
OU III South Boundary Air Stripping Tower
2009 SPDES Equivalency Permit Levels

Parameters	Permit Limit*	Max. Observed Value
pH range (SU)	6.5 – 8.5	6.7–7.8
carbon tetrachloride	5 µg/L	ND
chloroform	7 µg/L	ND
dichlorodifluoromethane	5 µg/L	ND
1,1-dichloroethane	5 µg/L	ND
1,1-dichloroethylene	5 µg/L	ND
methyl chloride	5 µg/L	ND
tetrachloroethylene	5 µg/L	ND
toluene	5 µg/L	ND
1,1,1-trichloroethane	5 µg/L	ND
1,1,2-trichloroethane	5 µg/L	ND
trichloroethylene	10 µg/L	ND

Notes:

*Maximum allowed by requirements equivalent to a SPDES permit.
ND = Not detected above method detection limit of 0.50 µg/L.
Required sampling frequency is monthly for VOCs and pH.

January – September 2009

Approximately 154 million gallons of water were pumped and treated. There were communications and electrical problems during the first quarter, which resulted in the system being off for the first three months of the year. Well EW-8 was put back in service in April 2009 due to a slight increase in TVOC concentrations noted in this well. Concentrations increased to 45 µg/L in April and then subsequently steadily declined back to 7 µg/L in October. The operation of EW-8 was stopped in November 2009 due to the decrease in concentrations. The system operated normally for the second and third quarter.

October – December 2009

The OU III South Boundary System pumped and treated approximately 47.5 million gallons of water. The system was off for part of December due to communications problems with the wells and the treatment system.

3.2.4.5 System Operational Data

System Influent and Effluent

Figure 3.2.4-3 plots the concentrations of TVOC concentrations in the extraction wells versus time. The overall influent water quality and the individual extraction wells show a general declining trend in concentrations. The system was also sampled monthly for tritium, which was not detected above the reporting limit in any sample during 2009. System influent and effluent sampling results are summarized on **Tables F-14** and **F-15**, respectively.

Cumulative Mass Removal

Average flow rates for each monthly monitoring period were used, in combination with the TVOC concentration in the air-stripper influent, to calculate the mass removed (**Table F-16**). The cumulative total of VOCs removed by the treatment system versus time is plotted on **Figure 3.2.4-4**. The 2009 total was approximately 85 pounds. Cumulatively, the system has removed approximately 2,715 pounds since it was started in June 1997.

Air Discharge

Table 3.2.4-2 shows the air emissions data from the OU III South Boundary system for 2009, and compares the values to levels stipulated in NYSDEC Air Guide 1 regulations. Emission rates are obtained through mass-balance calculations for water treated during that time (**Table F-14**). The concentration of each constituent was averaged for the year, and that value was used in the calculation. System air emissions were below allowable levels.

Table 3.2.4-2.
OU III South Boundary Air Stripper
2009 Average VOC Emission Rates

Parameter	Allowable ERP*	Actual** ER
carbon tetrachloride	0.022	0.0009
chloroform	0.0031	0.0002
1,1-dichloroethane	10***	<0.000025
1,2-dichloroethane	0.008	<0.0001
1,1-dichloroethylene	0.034	0.0001
cis-1,2-dichloroethylene	10***	<0.0000
trans-1,2-dichloroethylene	10***	0
tetrachloroethylene	0.387	0.0080
1,1,1-trichloroethane	10***	0.0003
trichloroethylene	0.143	0.0002

Notes:

ERP = Emissions Rate Potential, stated in lb/hr.
* ERP is based on NYSDEC Air Guide 1 Regulations.
** Actual emission rate reported is the average for the year.
*** 6 NYCRR Part 212 restricts emissions of VOCs to a maximum of 10 lb/hr without controls.

Extraction Wells

In general, the extraction wells continued to show slowly decreasing VOC concentrations during 2009 (**Figure 3.2.4-3**). **Table F-13** summarizes the data for the extraction wells. **Table 3.2.4-3** shows the monthly extraction well pumping rates.

3.2.4.6 System Evaluation

The OU III South Boundary Pump and Treat System performance can be evaluated based on the five major decisions identified for this system resulting from the groundwater DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?

No. There were no unusual or unexpected VOC concentrations observed in the monitoring and extraction wells associated with the OU III South Boundary Pump and Treat System during 2009.

2. Has the plume been controlled?

Yes, the capture zone for the OU III South Boundary Pump and Treat System includes the 50 µg/L isocontour, which is the capture goal of this system **Figure 3.0-1**.

3. Is the system operating as planned? Specifically, is the aquifer being restored at the planned rate for this treatment system?

Yes. The OU III South Boundary System continues to be effective in removing VOCs from the deep portions of the Upper Glacial aquifer. The overall reduction in the high-concentration areas of the plume near the south boundary is evident.

The OU III South Boundary System is planned to operate for 15 years; at the end of 2009 it had operated for approximately 12.5 years. The system is removing contamination at the expected rate and hydraulic control of the plume is demonstrated. The duration of operation for the OU III South Boundary System is dependent on the effectiveness of the Middle Road System, and the travel time from Middle Road to the South Boundary. The Middle Road System started operation approximately 4.5 years after the OU III South Boundary System. The contaminant travel time from Middle Road to the OU III South Boundary system is approximately 5 to 10 years. Therefore, the high concentrations observed in the vicinity of well 113-17 (located just south of the Middle Road System) will likely determine the operating period of this system (**Figures 3.2-1 and 3.2-2**). This well has shown a significant decrease in TVOC concentrations from over 1,300 µg/L to 162 µg/L in October. Monitoring well 121-45 was installed in 2008 and had a concentration of 215 µg/L in October 2009. It was installed to monitor concentrations of TVOCs immediately upgradient of extraction well EW-4, which has historically had the highest TVOC concentrations. Monitoring well 121-43 located downgradient of EW-4 was installe din 2003. It has shown persistently elevated concentrations of VOCs. It is screened slightly deeper then well EW-4. This may be due to this well being located near the stagnation zone downgradient of EW-4 which has slowed down the migration of the VOCs that were present in this area prior to system startup. Or it may be that some VOC contamination is migrating under well EW-4. A vertical profile is planned near well EW-4 to evaluate if this is occurring.

4. Can the groundwater treatment system be shut down?
No, the system has not met all shutdown requirements (see below).

4a. Have asymptotic TVOC concentrations been reached in core wells?
The average TVOC concentrations of the OU III South Boundary wells showed a slight decrease in 2009 (**Figure 3.2.4-5**).

4b. Is the mean TVOC concentration in core wells less than 50 µg/L?
Yes, the average TVOC concentration in 2009 was 23 µg/L **(Figure 3.2.4-5)**.

4c. How many individual plume core wells are above 50 µg/L?
One core well, 121-45, has TVOC concentrations above 50 µg/L. Extraction well EW-4 also has concentrations above 50 µg/L.

4d. During pulsed operation of the system, is there significant concentration rebound in the core wells?
To date, the OU III South Boundary System has not been pulsed.

5. Have the groundwater cleanup goals been met? Specifically, have MCLs been achieved (expected by 2030)?
No. MCLs have not been achieved for individual VOCs in plume core wells. Based on modeling results, MCLs are expected to be achieved by 2030, as required by the OU III ROD.

3.2.4.7 Recommendations

The following are recommendations for the OU III South Boundary Pump and Treat System and groundwater monitoring program:

- Maintain wells EW-6, EW-7, EW-8, and EW-12 in standby mode. The system's extraction wells will continue to be sampled on a quarterly basis. The wells will be restarted if extraction or monitoring well data indicate TVOC concentrations exceed the 50 µg/L capture goal.
- Maintain the routine operations and maintenance monitoring frequency implemented last year.
- It is recommended that a vertical profile be installed near well EW-4 to evaluate how deep the high concentrations of VOCs are near the extraction well. This well should be installed to a depth of approximately -160 feet below MSL, until the Magothy Brown Clay is encountered. This will help evaluate whether the VOCs detected in well 121-43 are caught in the stagnation zone or may be passing under well EW-4.

This page intentionally left blank.

3.2.5 Western South Boundary Pump and Treat System

The Western South Boundary Pump and Treat System was designed to capture TVOC concentrations exceeding 20 µg/L in the Upper Glacial aquifer along the western portion of the BNL south boundary. The system reduces additional off-site migration of the contamination, and potential impacts of the VOC plume to the Carmans River. The system began operating in September 2002 and was changed to pulse pumping in late 2005, one month on and two months off. Based on increasing VOC concentrations in a monitoring well, extraction well WSB-1 was put back into full-time operation starting in November 2008 and has continued full-time through 2009. Extraction well WSB-2 remains in a pulse-pumping mode.

3.2.5.1 System Description

A complete description of the Western South Boundary Treatment System is contained in the *Operations and Maintenance Manual for the Western South Boundary Treatment System* (BNL 2002b).

3.2.5.2 Groundwater Monitoring

A network of 16 wells is used to monitor this plume. As noted below, well 103-15 was installed in 2009. Their locations are shown on **Figure 3.2.5-1**. The wells are sampled at the O&M phase frequency (see **Table 1-5** for details).

3.2.5.3 Monitoring Well Results

The primary VOCs associated with this plume are dichlorodifluoromethane (Freon-12), TCA, TCE, and chloroform. VOC contamination is located in the mid to deep Upper Glacial aquifer. Groundwater monitoring for this system was initiated in 2002. **Figure 3.2-1** presents fourth-quarter 2009 monitoring well concentrations. A summary of key monitoring well data for 2009 follows:

- Monitoring well 119-06 was installed at the location of WSB VP-1 in 2008 along Middle Road. This core well had TVOC concentrations up to 170 µg/L in December 2008, with TCA (100 µg/L) as the primary compound. During 2009, this well showed a steady decrease in TVOC concentrations from 114 µg/L in February to 87 µg/L in April and a leveling off for the third and fourth quarters averaging 35 µg/L, (primarily TCA and DCE). This leveling off is an indication of upgradient high concentrations passing through the vicinity of the Middle Road monitoring well.
- As a follow up to the 2008 report recommendations, due to the elevated dichlorodifluoromethane detected at the deepest interval, 192 feet, in WSB VP-7 between Middle Road and Princeton Avenue, monitoring well 103-15 was installed in the first quarter of 2009. This well was sampled in May, July and November of 2009 and analysis indicates VOCs exceeding DWS were dichlorodifluoromethane and trichloroethylene. TVOC values for this well indicate a steady increase over the three quarters of 26, 62 and 69 µg/L respectively. The highest concentration of dichlorodifluoromethane was in November 2009 at 55 µg/L.
- TVOC concentrations in plume core wells 121-42 and 127-06, located upgradient of extraction well WSB-2, and well 127-04 located at well WSB-2 have remained around 20 µg/L or less since 2005. TVOC concentrations in core well 126-15, located midway between the two extraction wells, has remained consistently below 5 µg/L from 2002 through most of 2006. In late 2006 and 2007, the concentrations began increasing but remained below 20 µg/L TVOCs. In 2009, the TVOC levels did not exceed 9 µg/L.
- TVOC concentrations in plume core well 126-14, located upgradient of WSB-1, have decreased slightly since system start-up, but have remained above 20 µg/L. TVOC concentrations (primarily TCA) in plume core well 126-11, located adjacent to WSB-1, dropped off significantly since system start-up; however, TVOC concentrations began increasing since 2006 and reached

68 µg/L in November 2009 (see trends on **Figure 3.2.5-2**). Plume core well 126-13 located just north of extraction well WSB-1 had the highest TVOC concentration detected in the seven downgradient plume core wells in 2009 with a value of 100 µg/L TVOC in November. The concentrations in this well increased significantly from 2008 of less than 10 µg/L TVOC in the fourth quarter. The sampling analysis indicates primarily TCA and DCE. Extraction well WSB-1 influent concentration data was not yet reflecting the increased TVOC values in December 2009.

- In bypass detection well 130-08, located south of extraction well WSB-1, the maximum TVOC concentration during 2009 was 32 µg/L in the second quarter. The highest individual VOC detected was dichlorodifluoromethane at 12 µg/L.
- In bypass well 126-16, located south and between the two extraction wells, TVOC concentrations were approximately 30 µg/L. Bypass well 127-07, located downgradient of WSB-2, has shown steadily declining VOCs since 2005. In 2009, TVOC concentrations were less than 10 µg/L and no individual compound exceeded DWS.

Table 3.2.5-1
OU III Western South Boundary Pump & Treat System
2009 SPDES Equivalency Permit Levels

Parameter	Permit Level (µg/L)	Max. Measured Value (µg/L)
pH range	6.5–8.5 SU	6.9–8.1 SU
carbon tetrachloride	5	<0.5
chloroform 7		<0.5
dichlorodifluoromethane 5		<0.5
1,1-dichloroethane 5		<0.5
1,1-dichloroethylene 5		<0.5
methyl chloride	5	<0.5
tetrachloroethylene 5		<0.5
toluene 5		<0.5
1,1,1-trichloroethane 5		<0.5
1,1,2-trichloroethane 5		<0.5
trichloroethylene 10		<0.5

Note:

Required effluent sampling frequency is 2x/month for VOCs and monthly for pH.

- Plume perimeter well 130-03, located west of extraction well WSB-1, had a maximum TVOC concentration of 33 µg/L in November 2009. This well has shown a decreasing trend from the historical high TVOC concentration of 58 µg/L in December 2004. The capture zones of the Western South Boundary extraction wells were not intended to include this area.

3.2.5.4 System Operations

During 2009, the extraction wells were sampled quarterly and the influent and effluent of the air-stripper tower were sampled twice per month. Extraction well WSB-1 continued full-time operation through 2009 due to increasing TVOC concentrations greater than the capture goal of 20 µg/L in upgradient core wells. System samples were analyzed for VOCs. In addition, the effluent sample was analyzed for pH and tritium twice a month. A tritium value of 590 pCi/L was detected in February 2009. **Table 3.2.5-1** provides the effluent limitations for meeting the requirements of the SPDES equivalency permit. The system's effluent discharges met the SPDES equivalency permit requirements. The system operations are summarized below.

January – September 2009

The treatment system operated normally from January to September. The WSB-1 extraction well operated for the entire year. The WSB-2 extraction well schedule was one month on and two months off. During this time, approximately 87 million gallons of groundwater were pumped and treated.

October – December 2009

The system operated normally with being down a few days due to an electrical outage. During this quarter, approximately 29 million gallons of groundwater were pumped and treated.

3.2.5.5 System Operational Data

Extraction Wells

During 2009, approximately 115 million gallons of groundwater were pumped and treated by the OU III Western South Boundary System, with an average flow rate of approximately 206 gpm while in operation. **Table 2-3** gives monthly pumping data for the two extraction wells. **Table 3.2.5-2** shows the monthly extraction well pumping rates. VOC and tritium concentrations for extraction wells WSB-1 and WSB-2 are provided on **Table F-17**. VOC levels in both wells had been showing a slight decreasing trend since system start-up in 2002, through 2005. In 2006 WSB-2 showed increasing TVOCs, but had been decreasing in 2007 and 2008. In the fourth quarter of 2009, WSB-2 is indicating a slight increasing trend and WSB-1 is expected to increase based on higher concentrations of upgradient VOCs showing up in adjacent monitoring wells. The maximum TVOC concentration in 2009 was 16 µg/L. Since 2006 there has been a slight increasing trend in WSB-1 TVOC concentrations; however, they were still lower than the 20 µg/L capture goal. **Figure 3.2.5-3** provides a graph of extraction well trends over time. Most of the individual VOC compounds were either below or slightly above the NYS AWQS.

Table 3.2.5-3
OU III Western South Boundary
2009 Air Stripper VOC Emissions Data

Parameter	Allowable ERP* (lb/hr)	Actual ERP (lb/hr)
carbon tetrachloride	0.016	<0.0001
chloroform 0.00	86	0.0001
1,1-dichloroethane 10**		<0.000038
1,2-dichloroethane 0.01	1	<0.0000
1,1-dichloroethene 0.19	4	0.00004
chloroethane 10**		<0.0001
1,1,1-trichloroethane 10**		0.0006
trichloroethylene 0.11	9	0.0001

Notes:
ERP = Emissions Rate Potential, stated in lb/hr.
* Based on NYSDEC Air Guide 1 Regulations.
** 6 NYCRR Part 212 restricts emissions of VOCs to a maximum of 10 lb/hr without controls.

System Influent and Effluent

Influent TVOC concentrations were less than 17 µg/L, and individual VOC concentrations were less than the NYS AWQS, except for TCA averaging above 6 µg/L for the second half of the year 2009. These levels are consistent with the historical influent concentrations. The influent consists primarily of dichlorodifluoromethane, TCA, TCE, and chloroform (**Tables F-18** and **F-19**).

The air-stripper system effectively removed all elevated contaminants from the influent groundwater. The system's effluent data were below the analytical method detection limit and below the regulatory limit specified in the equivalency permit conditions.

Cumulative Mass Removal

Average flow rates for each monthly monitoring period were used, in combination with the TVOC concentration in the air-stripper's influent, to calculate the pounds of VOCs removed per month (**Table F-20**). The cumulative mass of VOCs removed by the treatment system is provided on **Figure 3.2.5-4**. During 2009, 12 pounds of VOCs were removed. A total of 66 pounds have been removed since the start-up of the system in 2002.

Air Discharge

Table 3.2.5-3 presents the VOC air emission data for the year 2009 and compares the values to levels stipulated in NYSDEC Air Guide 1 regulations. Emission rates are calculated through mass balance for water treated during operation. The VOC air emissions were well below allowable levels.

3.2.5.6 System Evaluation

The Western South Boundary Pump and Treat System performance can be evaluated based on the five major decisions identified for this system from the groundwater DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?
Yes. The contingency plan was implemented during 2009. Permanent monitoring well 103-15 has been installed during the first quarter of 2009 because of the high concentrations in the temporary well installed previously at this location.

2. Has the plume been controlled?
Yes. VOC concentrations in the plume perimeter wells (except 130-03) remained stable at or below the drinking water standard during 2009, indicating that the plume is being controlled as shown on **Figure 3.2.5-1**. Perimeter well 130-03 had been slowly decreasing since late 2004 with a slight increase of 33 µg/L in November 2009. The capture zone of WSB-1 was not intended to include this area. As noted above, low VOC concentrations in the bypass wells were present before the system was operational and not within the capture zone of the extraction wells. The capture zone for the treatment system is depicted on **Figure 3.0-1**.

3. Is the system operating as planned? Specifically, is the aquifer being restored as planned?
Yes. The system is operating as planned based on meeting the capture goal of 20 µg/L TVOCs. Plume core monitoring wells began showing decreasing concentration trends since 2002. In 2009, VOC concentrations in well 126-11 and 126-13 started to increase steadily as discussed previously. VOCs present in monitoring wells immediately upgradient of WSB-1 (i.e., 126-11, 126-13 and 126-14) will be captured by the system. Based on groundwater modeling performed in late 2008, it is projected that VOCs detected in wells installed along Middle Road during 2008, will be captured by existing extraction well WSB-1. However, the estimated duration for operation of the treatment system would be extended until approximately 2019 to ensure complete capture of the upgradient portion of the plume.

4. Can the groundwater treatment system be shut down?
No, the system has not met all shutdown requirements. However, the extraction wells began pulse pumping in late 2005 based on low VOC concentrations in core monitoring wells and the extraction wells (see 4a and 4b). Extraction well WSB-1 was placed back into full-time operation in late 2008 and continued through 2009 due to elevated VOCs in nearby monitoring wells.

4a. Have asymptotic VOC concentrations been reached in core wells?
No. Several core wells upgradient of WSB-1 have been indicating a steady increase in VOC concentrations.

4b. Is the mean TVOC concentration in core wells less than 20 µg/L?
No. The mean TVOC concentration in the core wells is 34 µg/L (**Figure 3.2.5-5**).

4c. How many individual plume core wells are above 20 µg/L TVOC?
TVOC concentrations in five of nine core wells were above 20 µg/L as discussed in Section 3.2.5.3.

4d. During pulsed operation of the system, is there significant concentration rebound in core wells?
No. As noted above, plume core well 126-11 has been steadily increasing since 2006, shortly after pulse pumping began. The highest TVOC concentration in 2009 was 68 µg/L. TVOC concentrations in the extraction wells increased slightly since 2006; however, they remained below 20 µg/L in 2009. Extraction well WSB-1 has been on full time during 2009.

5. Have the groundwater cleanup goals been met? Are MCLs expected to be been achieved by 2030?
No. MCLs have not been achieved for individual VOCs in all plume core wells. However, MCLs are expected to be achieved by 2030.

3.2.5.7 Recommendations

The following are recommendations for the OU III Western South Boundary Treatment System and groundwater monitoring program:

- Continue full-time operation of extraction well WSB-1, and pulse pumping of WSB-2 at the schedule of one month on and two months off. This process will continue and any changes to the VOC concentrations in the influent and the monitoring wells will be evaluated.
- If any of the three bypass detection wells show increasing VOC trends, the need to take further action will be evaluated.
- Due to indications of increased TVOC concentrations in plume core monitoring wells in close proximity to extraction well WSB-1, installation of a permanent monitoring well should be implemented during 2010. The well should be located approximately 700 feet north of WSB-1 to provide a data point between this well and the Middle Road.
- To better define the northerly portion of the core area of the plume where higher concentrations of dichlorodifluoromethane have been detected, two temporary wells should be installed in the vicinity of Princeton Avenue.
- Maintain the routine O&M monitoring frequency that began in 2005.

This page intentionally left blank.

3.2.6 Industrial Park In-Well Air Stripping System

This section summarizes the operational data from the OU III Industrial Park In-Well Air Stripping System for 2009 and presents conclusions and recommendations for its future operation. The system began operation in September 1999. The OU III Industrial Park system was designed to contain and remediate a portion of the OU III plume between BNL's southern boundary and the southern boundary of the Parr Industrial Park. **Figure 3.2.6-1** illustrates the extent of the OU III contaminant plume in the vicinity of the Industrial Park. The primary VOCs associated with this portion of the OU III plume are TCA, TCE, and carbon tetrachloride.

3.2.6.1 System Description

The OU III Industrial Park system consists of a line of seven in-well air stripping treatment wells. Each treatment well is constructed with two well screens separated by an inflatable packer. Contaminated groundwater is withdrawn from the aquifer via submersible pump through a lower screen (extraction screen) set at the base of the treatment well. The groundwater is pumped to a stripping tray located in a below ground vault over the wellhead. After passing through the stripping tray, treated groundwater flows back down the well and is recharged to a shallower portion of the aquifer through an upper screen (recharge screen). Some of the treated groundwater that is recharged through the upper screen recirculates through the cell and is drawn back into the extraction screen for further treatment, while the balance flows in the direction of regional groundwater flow.

A closed-loop air system through a single blower keeps the vault under a partial vacuum. This vacuum draws air from below the stripping tray as contaminated groundwater is discharged on top. VOCs are transferred from the liquid phase to the vapor phase as contaminated groundwater passes through the stripping tray. The contaminated air stream is carried from the vault to a treatment and control building, where it is passed through two GAC units in series to remove the VOCs. Treated air is then recirculated back to the wellhead. The carbon units, system blower, and system control panel are all housed in a one-story masonry treatment building. A complete description of the system is included in the *Operations and Maintenance Manual for the OU III Offsite Removal Action* (BNL 2000b).

3.2.6.2 Groundwater Monitoring

Well Network

The monitoring well network consists of 43 wells and is designed to monitor the VOCs in the vicinity of the industrial park south of the site, and the effectiveness of the in-well air stripping groundwater treatment system on this part of the high-concentration OU III VOC plumes. The wells are located throughout the industrial park and on Carleton Drive, as shown on **Figure 3.2.6-1.** Screen depths are set to capture water levels at multiple depths and to obtain water quality data as follows: 1) above the treatment well effluent depth, 2) at the effluent depth, and 3) at the treatment well influent depth.

Sampling Frequency and Analysis

Plume core and perimeter wells are sampled either annually or semiannually and analyzed for VOCs. Bypass detection and Magothy wells are sampled quarterly and analyzed for VOCs (**Table 1-5**).

3.2.6.3 Monitoring Well Results

The complete analytical results are included in **Appendix C**. VOC concentrations in the plume perimeter wells that monitor the width of the plume (000-245 and 000-272) remained below NYS AWQS during 2009. Based on these data, the plume is effectively bounded by the current well network. **Figure 3.2.6-1** shows the plume distribution based on fourth-quarter 2009 data. The vertical extent of contamination is shown on **Figure 3.2.6-2**. The location of this cross section (G–G') is illustrated on **Figures 3.2-1 and 3.2.6-1**. The 2009 results for key monitoring wells are:

Plume Core Wells

- Wells 000-253 (just east of UVB-1) and 000-256 (between UVB-1 and UVB-2), which both contained TVOC concentrations over 1,000 µg/L in 2001, have continued to show concentrations at or below NYS AWQS. Since 2003, UVB-1 has remained in standby due to low VOC concentrations.
- Well 000-259 (located between UVB-2 and UVB-3), which was sampled in May and November 2008, had elevated TVOC concentrations of 102 µg/L and 161 µg/L, respectively. However, in 2009 the sampling showed a significant drop to 21 and 36 µg/L. This is consistent with data observed in extraction wells UVB-2 and UVB-3.
- A steady decline in TVOC concentrations was observed in well 000-112 (immediately upgradient of UVB-1 and UVB-2) since 1999, when concentrations were near 2,000 µg/L. TVOC concentrations were at 5 µg/L in November 2009 (**Figure 3.2.6-3**).
- Well 000-262 (between UVB-4 and UVB-5) began showing decreasing TVOC concentrations in 2002 (**Figure 3.2.6-3**). The TVOC concentration in this well peaked at 2,175 µg/L in 2001 and has fluctuated for the past few years between 200 and 600 µg/L. Data from 2009 showed TVOC concentrations of 209 µg/L in May and 225 µg/L in November.
- The TVOC concentration in well 000-268 (between UVB-6 and UVB-7) was 6 µg/L in November 2009 (**Figure 3.2.6-3**). This is consistent with data observed in UVB wells 6 and 7.

Plume Bypass Wells

- TVOC concentrations in most of the wells located near Carleton Drive were stable or decreasing during 2009. Wells 000-431 and 000-432 serve as bypass monitoring points downgradient of UVB-2. Well 000-432 has shown TVOC concentrations between 6 and 11 µg/L during 2009. TVOC concentrations in 000-431 were below NYS AWQS during 2009. The low VOC concentrations in these wells indicate that the system is effective in hydraulically controlling the plume.
- TVOC concentrations in wells 000-275, 000-276, and 000-277 are below the capture goal of 50 µg/L, indicating that the system is effective in capturing the plume. The highest concentration observed was 11 µg/L (February 2009) in well 000-276.
- In 2008, well 000-278 showed a significant increase in TVOC concentrations, from 14 µg/L in January to 217 µg/L in November. This well is directly downgradient of well UVB-4, which had been shutdown for about one year, and it is likely detecting contaminants that were hung up in the "stagnation zone." The data from November 2009 shows concentrations decreasing to47 µg/L.
- TVOC concentrations in well 000-273 varied from 49 µg/L in February 2009 to 11 µg/L in July. Well 000-274 varied from 105 µg/L in February 2009 to 31 µg/L in November 2009. These wells are located immediately downgradient of well UVB-1, which was shut down in October 2005. These VOC concentrations observed in the monitoring wells are from contamination that was in the "stagnation zone" downgradient of UVB-1 while it was operating. Now that it has been shut down, the contaminants have migrated downgradient of the extraction well. These contaminants could not be captured by the extraction well because they were too far downgradient but were held up by the pumping. As these higher concentration slugs of contaminants are passing by the monitoring wells, the concentrations first increase then decline as seen in 2009. These contaminants will be captured by the down gradient LIPA extraction wells.

Perimeter Wells

VOC concentrations for individual constituents remained below NYS AWQS (5 µg/L) in each of the shallow wells, screened to monitor above the adjacent UVB effluent well screens.

3.2.6.4 System Operations

In 2009, approximately 150 million gallons of groundwater were pumped and treated by the Industrial Park In-Well Air Stripping System.

Operating Parameters

Water samples are obtained monthly from each of the seven extraction wells before air stripping in each UVB tray and after treatment. The samples are analyzed for VOCs. These samples determine the wells' removal efficiency and performance. Based on these results, operational adjustments are made to optimize the system's performance.

System Operations

System extraction well pumping rates are included on **Table 3.2.6-1**. The following summarizes the system operations for 2009.

Well UVB-1 remained in standby mode throughout the year.

January – September 2009

The system was off from March 19 to 25 due to maintenance work on the blower unit. Various wells were off for short periods of times due to issues ranging from electrical problems to routine well maintenance. They system pumped and treated a total of approximately 118 million gallons of water

October – December 2009

In October 2009, well UVB-7 was placed in standby mode as TVOC concentrations have remained below 10 µg/L in this well. Wells UVB-3 and UVB-4 were off for November due to electrical problems and were re-started in December. The rest of the system operated normally for the remainder of the period. Well UVB-1 remained in standby mode for this period. Approximately 30 million gallons were treated during this period.

3.2.6.5 System Operational Data

Recirculation Well Influent and Effluent

During 2009, influent TVOC concentrations in the treatment system wells showed a steady or declining trend. (**Figure 3.2.6-4**). The corresponding effluent well concentrations (**Figure 3.2.6-5**) showed decreasing or stable TVOC concentrations for the year. UVB-1 remained in standby mode for 2009. There was significant downtime for individual wells in 2009 due to electrical problems, flow meter issues and routine maintenance and cleaning of the wells.

For 2009, the overall average removal efficiency was 70 percent (**Table F-21**). This is lower than historical removal rates of 90 to 95 percent but is due to so many of the compounds being near the method detection limit and below AWQS. Well UVB-1 was not used in this calculation because it was off.

Cumulative Mass Removal

Calculations were performed to determine the VOC mass removed from the aquifer by the remediation wells during the year. The average estimated flow rates for each monthly monitoring period were used, in combination with the influent and effluent TVOC concentrations. **Table F-22** summarizes these data. During 2009, flow averaged approximately 49 gpm per well for the five operating wells. **Figure 3.2.6-6** plots the total pounds of VOCs removed by the treatment system vs. time. During 2009, 12 pounds were removed from the aquifer, with a total of 1,045 pounds removed since 1999.

Air Treatment System

Air samples were collected quarterly from the GAC vessels prior to treatment, between the two vessels, and after the second vessel (effluent). The samples were used to determine when a GAC change-out was needed. In addition, airflow rates were recorded to optimize the efficiency of individual recirculation wells.

Airflow rates are measured for each in-well air-stripping unit inside the treatment building. These rates averaged 529 cfm during 2009 (**Table F-23**).

3.2.6.6 System Evaluation

The OU III Industrial Park In-Well Air Stripping System performance can be evaluated based on the five major decisions identified for this system resulting from the groundwater DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?
No. There were no unusual or unexpected VOC concentrations observed in the monitoring wells or extraction wells associated with the OU III Industrial Park System during 2009.

2. Has the plume been controlled?
Yes. An analysis of the plume perimeter and bypass well data reveals that there were no significant VOC concentration increases in these wells during 2009, higher concentrations in wells 000-273 and 000-274, 000-277 and 000-278 during 2008 have declined significantly in 2009. This was expected, as explained in **Section 3.2.6.3**. Therefore, it is concluded that there has been no plume growth and the plume continues to be controlled.

The capture zone for the OU III Industrial Park System is depicted on **Figure 3.0-1**. The capture zone depicted includes the TVOC 50 µg/L isocontour, which is the capture goal of this system.

3. Is the system operating as planned? Specifically, is the aquifer being restored at the planned rate for this treatment system?
Yes. The treatment system is effectively removing contamination. The current estimate for treatment system operations is for the system to operate through 2012. The OU III Industrial Park System continues to effectively remove VOCs from the deep Upper Glacial aquifer. **Figure 3.2-3** compares the OU III plume from 1997 to 2009. The cutoff of the high-concentration areas of the plume near the south boundary is evident. This is consistent with the dramatically reduced concentrations of VOCs being observed in the industrial park monitoring and extraction wells.

The overall trend in the mean TVOC concentrations in the core groundwater monitoring wells is declining (**Figure 3.2.6-7**). The system is removing contamination at the expected rate and hydraulic control of the plume is demonstrated; hence, it is operating as planned.

4. Can the groundwater treatment system be shut down?
No, the system has not met all shutdown requirements (see below).

4a. Have asymptotic TVOC concentrations been reached in core wells?
No. Concentrations show an overall decreasing trend.

4b. Is the mean TVOC concentration in core wells less than 50 µg/L?
Yes, the mean TVOC concentration in the plume core wells was 31.6 µg/L in November 2009.

4c. How many individual plume core wells are above 50 µg/L TVOC?
One (000-262) of the nine plume core wells had TVOC concentrations exceeding 50 µg/L in 2009.

4d. During pulsed operation of the system, is there significant concentration rebound in the core wells?
To date, the OU III Industrial Park In-Well Air Stripping System has not been pulsed.

5. Have the groundwater cleanup goals been met? Have MCLs been achieved (expected by 2030)?
No. MCLs have not been achieved for individual VOCs in plume core wells. Based on model predictions and monitoring results, MCLs are expected to be achieved by 2030, as required by the OU III ROD.

3.2.6.7 Recommendations

The following are recommendations for the Industrial Park In-Well Air Stripping System and groundwater monitoring program:

- The current routine operations and maintenance monitoring frequency will be maintained during 2010. The system will continue operations at 60 gpm per well except for well UVB-1 and UVB-7 which are to remain in a standby mode. It is recommended that well UVB-2 be placed in standby as TVOC concentrations have dropped to below 5 µg/L in this well and all of the monitoring wells in the vicinity are below 50 µg/L TVOC. Monthly recovery well sampling will continue, and if TVOC concentrations greater than 50 µg/L are observed, wells UVB-1, UVB-2 or UVB-7 will be restarted.
- Currently all the monitoring wells except 000-262 are below the capture goal of 50 µg/L. All of the extraction wells now have influent concentrations below the capture goal of 50 µg/L. If concentrations in well 000-262 drop below the TVOC 50 µg/L capture goal a petition to shutdown this system may be submitted to the regulators.
- A temporary well should be installed and sampled between wells UVB-3 and UVB-4 to evaluate the VOC concentrations in this area since no monitoring wells are present in this area.

This page intentionally left blank.

3.2.7 Industrial Park East Pump and Treat System

This section summarizes the 2009 operational and monitoring well data for the OU III Industrial Park East (IPE) Groundwater Pump and Treat System, and presents conclusions and recommendations for its future operation. The system began full operation in June 2004 to provide capture and control for a downgradient portion of the OU III VOC plume, which has migrated beyond the BNL site boundary. The Petition to Shutdown the OU III Industrial Park East Groundwater Treatment System was submitted to the regulators for review in early October 2009. In November 2009, the regulators concurred with the Petition. The system was placed in standby in December 2009.

3.2.7.1 System Description

The IPE treatment facility (Building OS-2) is located at the Industrial Park immediately east of Building OS-1, the Industrial Park Groundwater Treatment System. This system includes two extraction wells and two recharge wells. Extraction well EWI-1 is screened in the Upper Glacial Aquifer and EW I-2 is screened in the upper portion of the Magothy aquifer (**Figure 3.2.7-1**). Extraction well EWI-1 is designed to operate at a maximum rate of approximately 120 gpm; extraction well EWI-2 is designed for approximately 100 gpm.

The treated water is recharged to the Upper Glacial aquifer through two recharge wells located near the extraction wells, designated as DWI-1 and DWI-2. A complete description of the system is contained in the *Operations and Maintenance Manual for the Industrial Park East Offsite Groundwater Remediation System* (BNL 2004c).

3.2.7.2 Groundwater Monitoring

The monitoring network consists of 12 wells (**Figure 1-2**) that are sampled quarterly and analyzed for VOCs. These wells monitor the VOC plume south of the Long Island Expressway (LIE) to Astor Drive in the East Yaphank residential area, as well as the effectiveness of the groundwater treatment system.

3.2.7.3 Monitoring Well Results

The primary VOCs associated with this portion of the OU III plume are TCA, trichloroethylene, and 1,1-dichloroethylene. Groundwater monitoring for this system was initiated in 2004; however, three of the wells have been monitoring the plume since 1999. Fourth-quarter well data are posted on **Figure 3.2.7.1**. The complete analytical results are in **Appendix C.** Results for key monitoring wells are as follow:

- The maximum TVOC concentration detected during 2009 was 31 μg/L in downgradient well 000-494 during the fourth quarter, with TCA (17 μg/L) as the highest individual VOC detection (**Figure 3.2.7-2**). This is a Magothy monitoring well screened to 310 feet below land surface and located 1,200 feet downgradient of the extraction wells. This contamination was likely downgradient of the extraction wells prior to their installation. Groundwater modeling projects that this contamination will attenuate to concentrations below NYS AWQS and achieve the OU III ROD Cleanup Goal.
- In plume core well 000-514, approximately 100 feet west of the extraction wells, VOC concentrations were less than NYS AWQS during 2009.
- VOCs in plume bypass well 000-493 have remained below the NYS AWQS since it was installed in June 2004.
- Upgradient wells 122-24 and 122-25, which had shown TVOC concentrations as high as 570 μg/L in 2002, were below NYS AWQS in 2008 and 2009.

3.2.7.4 System Operations

Operating Parameters

The influent, midpoint, and effluent of the carbon vessels are sampled once a month and analyzed for pH and VOCs. The extraction wells are sampled monthly and are analyzed for VOCs. Sampling for pH and VOCs adheres to the requirements of the SPDES equivalency permit. The system's effluent samples during this period of operation were within the permit levels (**Table 3.2.7-1**). In November 2007, the system began a one month on and one month off pulse-pumping schedule.

Table 3.2.7-1.
OU III Industrial Park East Pump & Treat System
2009 SPDES Equivalency Permit Levels

Parameters	Permit Limit (µg/L)	Max. Measured Value (µg/L)
pH (range)	5.5–8.5 SU	5.6–62 SU
bromoform 50		<0.50
carbon tetrachloride	5	<0.50
chloroform 5		0.73
methylene chloride	5	<0.50
tetrachloroethylene 5		<0.50
toluene 5		<0.50
trichloroethylene 10		<0.50
1,2-dichloroethane 5		<0.50
1,1-dichloroethane 5		<0.50
1,1-dichloroethylene 5		<0.50
1,1,1-trichloroethane 5		<0.50

Note:
Required sampling frequency is monthly for VOCs and pH.

System Operations

The following information summarizes the system operations for 2009.

January – September 2009

The system operated normally for the majority of this period with the system pulse pumping one month on and one month off Twenty-nine million gallons were pumped and treated during the first three quarters of 2009.

October – December 2009

The system operated normally for this period still in a pulse pumping mode. The system pumped and treated 7.4 million gallons of groundwater this quarter. The Petition to Shutdown the OU III Industrial Park East Groundwater Treatment System was submitted to the regulators for review in early October 2009. In November 2009, the regulators concurred with the Petition. The system was placed in standby mode in December 2009.

Extraction Wells Operational Data

During 2009, approximately 37 million gallons were pumped and treated by the IPE system. The system was pulse pumped, one month on and one month off, so the average rate for the months it was in operation was 140 gpm. **Table 3.2.7-2** shows the monthly pumping data for the system. VOC concentrations for the IPE extractions wells are provided on **Table F-24.** In 2009, TVOC concentrations in EWI-1 ranged from 2.5 to 3.1 µg/L and 6.5 to 8.2 µg/L in EWI-2. All individual VOC compounds were below AWQS in both extraction wells.

3.2.7.5 System Operational Data

System Influent and Effluent

The overall VOC influent concentrations to the carbon vessels were consistently below AWQS in 2009 (**Figure 3.2.7-3**). **Tables F-26** and **F-27** present the influent and effluent data.

Cumulative Mass Removal

The mass of VOCs removed from the aquifer was calculated using average flow rates for each monthly monitoring period and influent concentrations to the carbon treatment system.

Table F-25 lists total pounds of VOCs removed by the treatment system in 2009. **Figure 3.2.7-4** plots mass removal versus time. Approximately 2.6 pounds of VOCs were removed from the aquifer during 2009 and 37.7 pounds since system start-up in 2004.

3.2.7.6 System Evaluation

This system is designed to achieve the overall OU III ROD objectives of minimizing plume growth and meeting AWQS in the Upper Glacial aquifer by 2030. According to the *OU III Explanation of Significant Differences* (BNL 2005a), AWQS within the Magothy aquifer must be met by 2065. The system will address the highest VOC concentration portion of the plume (above 50 µg/L TVOC).

The Industrial Park East Pump and Treat System performance during 2009 can be evaluated based on the five major decisions identified for this system from the groundwater DQO process:

1. Was the BNL Groundwater Contingency Plan triggered?
No. There were no unusual or unexpected VOC concentrations observed in the monitoring wells or extraction wells associated with the Industrial Park East Groundwater Pump and Treat System during 2009.

2.Has the plume been controlled?
Yes, the downgradient monitoring shows concentrations of TVOCs below the capture goal of 50 µg/L.

3. Is the System operating as planned?
Yes, as planned, the system is in a shutdown monitoring period.

4. Can the groundwater treatment system be shut down?
Yes, the system has met all shutdown requirements.

4a. Have asymptotic VOC concentrations been reached in core wells?
All IPE monitoring wells are below the capture goal of 50 µg/L for the treatment system. Therefore reaching asymptotic conditions is no longer required since other shutdown criteria have been met.

4b. Is the mean TVOC concentration in core wells less than 50 µg/L (expected by 2025)?
Yes, all core wells are less than 50 µg/L.

4c. How many individual plume core wells are above 50 µg/L?
None.

4d. During pulsed operation of the system, is there significant concentration rebound in the core wells?
The Industrial Park East System began pulse pumping in November 2007, and no rebound was observed prior to shutdown in December 2009.

5. Have the groundwater cleanup goals been met? Specifically, have MCLs been achieved in the Upper Glacial aquifer (expected by 2030) and the Magothy aquifer (expected by 2065)?
Yes for the Upper Glacial aquifer currently MCLs have been achieved for individual VOCs in all IPE plume core wells. MCLs are expected to be achieved by 2065 for the Magothy aquifer as required by the OU III ROD and ESD.

3.2.7.7 Recommendations

The following is recommended for the Industrial Park East Pump and Treat System and groundwater monitoring program.

- Continue the current groundwater monitoring post shutdown monitoring schedule.
- It is recommended that one additional downgradient monitoring well be installed in the vicinity of monitoring well 000-107 on Stratler Drive to monitor Magothy contamination identified in well 000-494.

3.2.8 North Street Pump and Treat System

The North Street Pump and Treat System addresses a VOC plume that originated at the Former Landfill/Chemical Holes area. The VOC plume is presently located south of the site boundary, with the leading edge extending south to the vicinity of the Brookhaven Airport. The groundwater pump and treat system began operating in May 2004 (**Figure 3.2.8-1**).

Groundwater treatment consists of two extraction wells operating at a combined pumping rate of approximately 450 gpm. This pumping captures the higher concentration portion of the VOC plume (i.e., TVOC concentrations greater than 50 µg/L) in the Upper Glacial aquifer, and will minimize the potential for VOC migration into the Magothy aquifer.

The North Street plume has been divided into two segments for remediation purposes. The area to the north of extraction well NS-2 is being addressed by the remediation system on North Street, whereas the Airport System handles the area to the south (**Figure 3.0-1**). The Airport System was constructed to address the leading edge of this plume (**Section 3.2.10**).

3.2.8.1 System Description

The North Street system consists of two extraction wells. Extracted groundwater is piped through two 20,000-pound GAC units and discharged to four injection wells. Both the North Street and North Street East systems share the four injection wells. Extraction well NS-1 is designed to operate at a rate of approximately 200 gpm, and extraction well NS-2 is designed for 250 gpm. A complete description of the system is contained in the *Operations and Maintenance Manual for the North Street/North Street East Offsite Groundwater Treatment Systems* (BNL 2004d).

3.2.8.2 Groundwater Monitoring

Well Network

A network of 26 wells monitors the North Street VOC plume (**Figure 1-2**). The monitoring program also addresses radiological contaminants that may have been introduced to groundwater in the OU IV portion of the site (particularly the Building 650 and 650 sump outfall areas), as well as the Former Landfill/Chemical Holes. Wells sampled under the Airport program are also utilized for mapping this plume.

Sampling Frequency and Analysis

The 26 wells are sampled and analyzed for VOCs at the operations and maintenance sampling frequency according to the schedule on **Table 1-5**. All 26 wells are also sampled and analyzed annually for tritium. Only one well, 000-211 was analyzed for Sr-90, gamma spectroscopy, and gross alpha/beta because of its use in the Industrial Park East program. This analysis for well 00-211 will discontinue during 2010 due to non-detect or below DWS concentrations being reported for several years.

3.2.8.3 Monitoring Well Results

The primary VOCs associated with this plume are carbon tetrachloride, PCE, TCA, and chloroform. **Figure 3.2-1** and **Figure 3.2.8-1** depict the TVOC plume distribution and include data from the monitoring wells. The complete groundwater monitoring well data for 2009 are included in **Appendix C**. A north–south hydrogeologic cross section (H–H') of the plume is provided on **Figure 3.2.8-2.** The location for the cross section is shown on **Figure 3.2-1**. A summary of key monitoring well data for 2009 follows:

- In 2009 the highest TVOC concentration in the plume was 114 µg/L in well 000-472 during fourth quarter sampling. TVOC concentrations have increased in this well since the April 2009 TVOC sampling value of 39 µg/L. The primary VOCs in this well are PCE with the highest concentrations averaging about half of the TVOCs with TCA and DCE accounting for the balance of VOCs above AWQS. This well is located west of North Street, approximately 90 feet west of extraction well NS-2. A portion of the leading edge of the higher concentration plume segment, has reached this location. This contamination will be captured partially by the North Street System and contamination beyond the capture zone of extraction well NS-2 will be captured by the Airport System.

- Plume core well 000-465 was installed 100 feet upgradient of extraction well NS-1 in 2004. This well had historically shown the highest VOC concentrations (primarily carbon tetrachloride) in the North Street area. TVOC concentrations were as high as 1,796 µg/L in 2004 and have since declined to 10 µg/L in the fourth quarter of 2009. This correlates well with the low TVOC concentrations observed in NS-1. VOC concentrations in plume core well 000-463, located approximately 200 feet north of NS-1, began to show a steady decline during 2009, as shown on **Figure 3.2.8-3.** Plume core well 000-154 had historically shown high VOC concentrations (primarily carbon tetrachloride). TVOC concentrations, greater than 1,000 µg/L were observed in this well in 1997 and 1998, but have steadily declined since then to approximately 6 µg/L in 2009. The trailing edge of the higher concentration segment of this plume has migrated south of this location.
- The bypass detection well 800-63, located on Vita Drive approximately 1,600 feet south of extraction well NS-1 has slowly declined to an average of 50 µg/L from a high in January 2008 of 174 µg/L.
- Several Airport monitoring wells (800-90, 800-92, 800-59, and 800-106) located south of the North Street extraction wells have displayed increasing TVOC concentrations over the past several years. Well 800-92 reached a high of 95 µg/L TVOCs in the first quarter 2009 and Magothy well 800-90 detected a maximum TVOC concentration of 102 µg/L in May 2009. The leading edge of the higher concentration segment, which had migrated beyond the North Street extraction well locations prior to that system start-up, has reached this location. This contamination will be captured by the Airport System treatment wells RTW-3A and RTW-4A.
- Historically, tritium has been detected in localized off-site areas and within the vicinity of the North Street VOC plume. The highest Tritium value was detected in bypass detection well 000-469 at a value of 840 pCi/L. Tritium concentrations continue to be well below the AWQS of 20,000 pCi/L. Tritium monitoring of North Street wells will continue in 2010.
- The plume continues to be controlled as indicated by perimeter wells.

3.2.8.4 System Operations

Monthly laboratory analyses are performed on influent, midpoint, and effluent samples from the GAC units. All monthly system samples are analyzed for VOCs, and the influent and effluent samples are also analyzed for pH. In addition, the system effluent is analyzed for tritium. **Table 3.2.8-1** provides the effluent limitations for meeting the requirements of the SPDES equivalency permit. The extraction wells are sampled quarterly for VOCs and tritium.

January – September 2009

Routine operations continued from January through September, with approximately 83 million gallons pumped and treated during the first three quarters. The system was off periodically to allow for scheduled carbon filter change-outs and for a longer period during the month of February due to injection well maintenance. Various electrical problems were experienced during the first three quarters, all of which required system restarts and repair.

Table 3.2.8-1
OU III North Street
2009 SPDES Equivalency Permit Levels

Parameters	Permit Limit (µg/L)	Max. Observed Value (µg/L)
pH (range)	5.5 – 8.5 SU	5.6 - 7.0 SU
carbon tetrachloride	5	ND
chloroform 5		ND
1,1-dichloroethane 5		ND
1,2-dichloroethane 5		ND
1,1-dichloroethylene 5		ND
tetrachloroethylene 5		ND
toluene 5		ND
1,1,1-trichloroethane 5 ND		
trichloroethylene 10		ND

Notes:
ND = Not detected above method detection limit of 0.50 µg/L.
Required effluent sampling frequency is monthly for VOCs and pH.

October – December 2009

Routine operations continued from October through December. The system was off periodically to allow for scheduled carbon change-outs. Approximately 51 million gallons were pumped and treated during this quarter.

3.2.8.5 System Operational Data

The system was operational from January to December 2009, with only minor shutdowns due to electrical outages, PLC issues, scheduled maintenance, and GAC change-outs.

Extraction Wells

Table F-28 contains the monthly pumping data and mass removal data for the system. **Table 3.2.8-2** shows the monthly extraction well pumping rates. **Figure 3.2.8-4** shows the plot of the TVOC concentrations from the extraction wells over time. VOC concentrations for the extraction wells are provided on **Table F-29**. TVOC values in well NS-1 remained consistent with 2008 values ranging from 10 to 21 µg/L over the year, and well NS-2 remained unchanged, with TVOC values ranging from 11 to 14 µg/L. The NS-1 TVOC concentrations correlate to the concentrations in monitoring wells 000-463, 000-464, and 000-465, located immediately upgradient of NS-1. There was no tritium detected in the extraction wells in 2009.

System Influent and Effluent

The 2009 VOC concentrations for the North Street carbon influent and effluent are summarized on **Tables F-30** and **F-31**. The combined influent TVOC concentration declined from 75 µg/L in December 2004 to 9 µg/L in December 2009. There was no detection of tritium (Table F-31 pCi/L) in the effluent in 2009. The influent is no longer sampled for tritium.

The carbon vessels for the system effectively removed the contaminants from the influent groundwater. All 2009 effluent data for this system were below the MDL.

Cumulative Mass Removal

The mass of VOCs removed from the aquifer by the OU III North Street Pump and Treat System was calculated using the average flow rates for each monthly monitoring period, in combination with the TVOC concentration in the carbon unit's influent, to calculate the pounds removed per month. The cumulative mass of VOCs removed by the treatment system vs. time is plotted on **Figure 3.2.8-5**. During 2009, approximately 135 million gallons of groundwater were pumped and treated by the North Street system, and approximately 10 pounds of VOCs were removed. Since May 2004, the system has removed 300 pounds of VOCs. The mass removal data are summarized on **Table F-28**.

3.2.8.6 System Evaluation

Figure 3.2.8-6 compares the TVOC plume from 1997 to 2009. The following changes were observed in the plume over this period:

- Monitoring wells 200 feet upgradient of NS-1 are showing a steady decline in TVOC concentrations.
- In wells downgradient of NS-1 and NS-2, TVOC concentrations are increasing as this plume segment that was south of the North Street system prior to start-up migrates toward the Airport. Monitoring wells 800-99 which is approximately 1,300 feet north of the Airport System and 800-101, just north of extraction well RTW-4A have low but steadily increasing values.

The OU III North Street Monitoring Program can be evaluated from the five decision rules identified in the groundwater DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?

No. There were no unusual or unexpected VOC or radionuclide concentrations in the monitoring wells or extraction wells associated with the North Street Pump and Treat System during 2009.

2. Has the plume been controlled?

Yes. An analysis of the plume perimeter and bypass wells shows that there have been no significant increases in VOC concentrations in 2009; thus, it can be concluded that that plume has not grown and continues to be controlled. As noted above, a segment of the plume now located near Vita Drive was beyond the capture zone of the North Street extraction well NS-1 at the time of system start-up. This portion of the plume will be addressed by the Airport extraction wells directly downgradient.

The Airport extraction wells are controlling the leading edge of the plume.

3. Is the system operating as planned? Specifically, is the aquifer being restored at the planned rate?

The hydraulic capture performance of the system is operating as modeled in the system design, and the system has been removing VOCs from the deep Upper Glacial aquifer. After five years of operation, the system influent VOC concentrations are steadily declining. The pre-design modeling predicted that the system will need to operate until 2012. Based on current data this prediction appears to remain valid.

4. Are there off-site radionuclides that would trigger additional actions?

No. As noted in **Section 3.2.8.3**, during 2009 there were only trace values of tritium detected in monitoring wells with concentrations below 850 pCi/L.

5. Can the groundwater treatment system be shut down?

No, the system has not met all shutdown requirements (see below).

5a. Have asymptotic TVOC concentrations been reached in core wells?
No. Although concentrations in a few of the upgradient wells have plateaued over time, overall asymptotic conditions have not yet been achieved.

5b. Are there individual plume core wells above 50 µg/L TVOC ?
Currently one of 12 plume core wells of the North Street system are showing concentrations greater than 50 µg/L TVOC and three are slightly below 50 µg/L TVOC. There are TVOC concentrations above 50 µg/L downgradient of the North Street system in Airport system monitoring wells just south of Moriches Middle Island Road. These higher concentrations will be captured by the Airport system extraction wells.

5c. During pulsed operation of the system, is there significant concentration rebound in the core wells?
To date, the North Street System has not been pulsed.

5d. Have the groundwater cleanup goals been met? Will MCLs be achieved by 2030?
MCLs have not been achieved for individual VOCs in plume core wells. Based on groundwater modeling and current system performance MCLs are expected to be achieved by 2030.

3.2.8.7 Recommendations

The following are recommended for the North Street Pump and Treat System and groundwater monitoring program:

- Maintain the operations and maintenance sampling frequency for monitoring wells.
- Due to historically low VOC concentrations, the sampling frequency for monitoring well 000-476 will be reduced from semiannual to annual.
- Due to the location of well 086-43 north of the Former Landfill (with respect to the plume) and since groundwater samples have not exceeded AWQS since it was installed, it is recommended that this well be dropped from the North Street monitoring program.
- VOCs have remained below AWQS for wells 115-33, 115-34, and 115-35 since they were installed in 1996, and there have been no detections above AWQS for well 115-32 since 2004. Additionally, tritium concentrations have been less than 400 pCi/L in each of these four wells since they were installed. As a result, it is recommended that these four wells be dropped from the North Street monitoring program.
- It is recommended to begin pulse-pumping extraction well NS-1, one month on and one month off during 2010, due to TVOC concentrations below 50 µg/L in upgradient monitoring wells. If there is any rebounding of higher TVOC concentrations, the extraction well will be placed back in to full-time operation.

This page intentionally left blank.

3.2.9 North Street East Pump and Treat System

This section summarizes the 2009 operational and monitoring well data for the OU III North Street East (NSE) Groundwater Pump and Treat System, and presents conclusions and recommendations for its future operation. The system began operation in June 2004 to provide capture and control of the downgradient portion of the OU I VOC plume, which has migrated beyond the BNL site boundary.

3.2.9.1 System Description

The North Street East System consists of two extraction wells. The water is pumped through two 20,000-gallon GAC units and the treated water is discharged to two of four injection wells located on North Street. Both the North Street and North Street East systems are located in the same building. The extraction well pump for NSE-1 is designed to operate at a rate of approximately 200 gpm; extraction well pump for NSE-2 is designed for 100 gpm. A complete description of the system is contained in the *Operations and Maintenance Manual for the North Street/North Street East Offsite Groundwater Treatment Systems* (BNL 2004d).

3.2.9.2 Groundwater Monitoring

The monitoring network consists of 15 wells (**Figure 1-2**). The monitoring program was designed to monitor the VOC plume off site, south of the OU I South Boundary System, as well as the efficiency of the NSE groundwater remediation system. During 2009, as recommended in the *2008 Groundwater Status Report* (BNL 2009b) the wells were sampled at shutdown monitoring frequency beginning in the second quarter (sampled quarterly). The wells are sampled at least annually for tritium. See **Table 1-5** for details.

3.2.9.3 Monitoring Well Results

Figure 3.2.9-1 shows the extent of the VOC plume. The plume originated from the Current Landfill and former HWMF (sources in OU I). The higher concentration segment of the plume (greater than 10 µg/L TVOCs) is just north of the LIPA right-of-way and extends to extraction well NSE-1.

Figure 3.1-2 depicts the vertical distribution of VOCs (primarily TCA, DCE, TCE, chloroform, and choroethane) within the deep Upper Glacial aquifer. The transect line for cross section A–A' is shown on **Figure 3.1-1**. **Figure 3.1-3** gives the historical trends in VOC concentrations for key core and bypass wells along the Current Landfill/former HWMF/NSE plume. **Appendix C** contains a complete set of 2009 analytical results for the 15 NSE program wells. A summary of key monitoring well data for 2009 follows:

- All monitoring wells in the plume have remained below the treatment system capture goal of 50 µg/L TVOCs from 2005 through 2009, except for one detection in well 000-478 (58 µg/L) in March 2005.
- TVOC concentrations in plume perimeter well 000-137, and core well 000-138 remained very low during 2009, with concentrations below 5 µg/L. Plume core well 000-124 was also less than 5 µg/L TVOC through 2009.
- The maximum plume TVOC concentration observed in 2009 was 47 µg/L in plume core well 000-477. The primary compounds identified in the sample were TCA at 26 µg/L and DCE at 11 µg/L in November 2009. This well is located in the west side of the plume approximately 250 feet upgradient of NSE-1. **Figure 3.1-3** indicates the trend graph for this well.
- In core well 000-478 the maximum TVOC concentration during 2009 was 5 µg/L. TVOC concentrations in core well 000-479 steadily decreased to below 3 µg/L in 2009. Plume core well 000-480 in 2009 has shown a steady decline in TVOC from second quarter sampling of 42 µg/L to 34 µg/L in the third quarter and 26 µg/L in the fourth quarter. The primary compounds in this

well during 2009 were TCA and chloroform. In November the concentrations of these compounds were 3.8 µg/L TCA and 17 µg/L for chloroform.

- TVOC concentrations in plume core well 000-481, located between NSE-1 and NSE-2, have been less than 5 µg/L in 2007 through 2009. In addition, nearby core wells 000-482, 000-483, 000-484, and 000-485 have remained below 5 µg/L since 2005.
- Plume bypass well 000-486 has not detected TVOC concentrations above 2 µg/L since it was installed in 2004.
- In 2009, the highest tritium concentration in the plume (780 pCi/L) was detected in well 000-215 in November. There have been no detections of tritium above 1,000 pCi/L in any of the NSE wells since 2005. Historically, the maximum tritium concentration in NSE monitoring wells was 8,200 pCi/L in well 000-215 (less than half of the AWQS) in 1998.

3.2.9.4 System Operations

Influent, midpoint, and effluent samples from the GAC units have been sampled every other month since the system is in pulse-pumping mode. The extraction wells were sampled quarterly during 2009. All NSE system samples were analyzed for VOCs. In addition, the influent and effluent samples were analyzed monthly for pH. During 2009, the extraction wells and system effluent were also analyzed quarterly and monthly for tritium, respectively. **Table 3.2.9-1** provides the effluent limitations for meeting the requirements of the SPDES equivalency permit.

Table 3.2.9-1.
OU III North Street East
2009 SPDES Equivalency Permit Levels

Parameters	Permit Limit (µg/L)	Max. Observed Value (µg/L)
pH range	5.5–8.5 SU	5.6– 6.66 SU
carbon tetrachloride	5	ND
chloroform 5		2.9
1,1-dichloroethane 5		ND
1,2-dichloroethane 5		ND
1,1-dichloroethylene 5		ND
tetrachloroethylene 5		ND
toluene 5		ND
1,1,1-trichloroethane 5		ND
trichloroethylene 10		ND

Notes:
ND = Not Detected above method detection limit of 0.50 µg/L.
Required effluent sampling freq. is monthly for VOCs and pH.

3.2.9.5 System Operational Data

The system was operational throughout 2009 with only minor shutdowns due to electrical outages, PLC issues, and scheduled maintenance. During 2009, approximately 5.9 pounds of VOCs were removed. Since June 2009, extraction well NSE-2 has been pulse pumped with the well on one month and off the next, and NSE-1 running full-time. Based on the pumpage report for 2009, **Table 2-3** there have been some interruptions with the pulse pumping due to maintenance being performed.

January through September 2009

The system operated normally with only minor shut downs due to electrical problems and injection well maintenance. The system pumped and treated approximately 53 million gallons of water.

October through December 2009

Due to PLC component repairs and repairs on NSE-1 and associated electrical components, the system was off for most of October and part of November. In this quarter, the system pumped and treated approximately 11 million gallons of water.

Extraction Wells

During 2009, 64 million gallons were pumped and treated by the NSE system; **Table 2-3** contains the monthly pumping data for the two extraction wells. **Table 3.2.9-2** shows the monthly extraction well pumping rates. **Figure 3.2.9-2** plots the TVOC concentrations in the extraction wells. VOC concentrations for NSE-1 and NSE-2 are provided on **Table F-32**. Steady TVOC concentration trends are noted for both wells during 2009, with concentrations averaging below 12 µg/L reported in NSE-1 and averaging below 4 µg/L in NSE-2 during the entire year.

System Influent and Effluent

VOC concentrations for 2009 for the carbon treatment influent and effluent are summarized on **Tables F-33** and **F-34**. Influent TVOC concentrations have been at or below 15 µg/L since 2005. In December 2009 influent TVOC concentrations reached 15 µg/L with the primary compounds being TCA, DCE and chloroform. The carbon treatment system effectively removed VOCs from the influent groundwater resulting in all 2009 NSE effluent concentrations being below the regulatory limit specified in the equivalency permit. No tritium has been detected in the system effluent above 600 pCi/L since the system began operating in 2004.

Cumulative Mass Removal

Using average flow rates for each monthly monitoring period, in combination with the VOC concentration in the system influent, the rate of contaminant removal was calculated (**Table F-35**). The cumulative mass of VOCs removed by the treatment system versus time is shown on **Figure 3.2.9-3**. During 2009, 5.9 pounds of VOCs were removed, with a cumulative total of 30 pounds of VOCs removed since system start-up in April 2004.

3.2.9.6 System Evaluation

The system began full operations in June 2004 and was predicted to run for approximately 10 years. The system is operating as designed. No operating difficulties were experienced beyond normal maintenance, and system effluent concentrations did not exceed SPDES equivalency permit requirements.

The North Street East Pump and Treat System performance can be evaluated based on the four major decisions identified for this system from the groundwater DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?

No. There were no unusual or unexpected concentrations of contaminants observed in monitoring or extraction wells associated with the NSE System.

2. Has the plume been controlled?

Yes. The system has been in operation for five years, and an analysis of the plume perimeter and bypass wells shows that there have been no significant increases in VOC concentrations in 2009, indicating that the plume has not grown and is controlled.

3. Is the system operating as planned? Specifically, is the aquifer being restored at the planned rate?

The system is operating as designed, and the system has been effectively removing VOCs from the deep Upper Glacial aquifer. System influent VOC concentrations have been less than originally projected. In addition, the monitoring wells have shown low concentrations following initial start-up of the system.

4. Can the groundwater treatment system be shut down?

Yes. The shutdown criteria of reaching less than 50 µg/L TVOCs for at least four consecutive sampling rounds has been met in the core monitoring and extraction wells. However, additional monitoring data will be collected. If concentrations remain below the capture goal of 50 µg/L TVOCs, in the first two quarters of 2010 and monitoring well 000-477 indicates declining trends, a Petition for Shutdown of the NSE system will be prepared during 2010.

4a. Have asymptotic TVOC concentrations been reached in core wells?
No. Since the shutdown criteria of less than 50 µg/L has been achieved, asymptotic conditions are no longer a required measure for system shutdown.

4b. Are there individual plume core wells above 50 µg/L TVOC ?
No. All NSE core wells are below 50 µg/L TVOCs.

4c. During pulsed operation of the system, is there significant concentration rebound in core wells?
No. Since the system was first shut down for pulse pumping starting October 2006, all core wells have remained low and no rebounding has been identified.

4d. Have the groundwater cleanup goals been met? Have MCLs been achieved (expected by 2030)?
No. MCLs have not been achieved for individual VOCs in plume core wells. However, MCLs are expected to be achieved by 2030.

3.2.9.7 Recommendations

The following recommendations are made for the North Street East Pump and Treat System and groundwater monitoring program:

- Extraction well NSE-1 will remain in full time operation. Shut off extraction well NSE-2, placing it in a Stand-by mode. If concentrations above the capture goal of 50 µg/L TVOCs are observed in either the core monitoring wells or the extraction wells, NSE-2 will be put back into full-time operation.
- Install a temporary well northwest (upgradient) of monitoring well 000-477 to determine the extent of VOC concentrations in this area.
- Drop monitoring well 800-54, located south of Moriches Middle Island Road, from the North Street East sampling program.
- Sample for Tritium only once per year in all wells.
- Following the review of additional monitoring well data, specifically evaluating 000-477, a Petition for Shutdown of the system will be prepared during 2010.
- Continue the shutdown monitoring frequency (sampled quarterly) for the NSE monitoring wells through 2010.

3.2.10 LIPA/Airport Pump and Treat System

This section summarizes the 2009 operational and monitoring well data for the OU III LIPA/Airport Groundwater Pump and Treat System, and presents conclusions and recommendations for its future operation. The LIPA system was designed to provide capture and control of the downgradient portion of the plume of VOCs in the Upper Glacial aquifer that had migrated past the Industrial Park System before that system became operational in 1999. The Airport Treatment System was designed to capture the leading edge of the OU III and OU I/IV VOC plumes and to prevent further migration of the plumes, which have migrated past the LIPA extraction wells and the North Street extraction wells.

3.2.10.1 System Description

The three components of the LIPA/Airport Pump and Treat System are as follows:

1. The Magothy extraction well (EW-4L) on Stratler Drive (**Figure 3.2.10-1**) addresses high-level VOCs identified in the Magothy aquifer immediately upgradient of this well on Carleton Drive. The capture goal for this well is 50 µg/L TVOCs.
2. The three LIPA extraction wells (EW-1L, EW-2L, and EW-3L) were installed to address high concentrations of VOCs in the Upper Glacial aquifer that had migrated past the Industrial Park System before that system became operational in 1999. The capture goal for these extraction wells is 50 µg/L TVOC.
3. Six extraction wells in the Airport System were installed to address the leading edge of the plumes and to prevent further migration of the plumes, which have migrated past the LIPA extraction wells and the North Street extraction wells. The sixth well (RW-6A) was added in 2007 to address concentrations of VOCs observed to the west of extraction well RTW-1A. The Airport system wells have a capture goal of 10 µg/L TVOC.

The water from the four LIPA wells is pumped to the treatment plant, about one mile south on Brookhaven [Town] Airport property, where it is combined with the water from the six airport extraction wells (RTW-1A through RW-6A) and treated via granular activated carbon. The treated water is released back to the ground via a series of shallow reinjection wells located on Brookhaven Airport and Dowling College property.

A more detailed description of this system is contained in the *Operations and Maintenance Manual for the LIPA/Airport Groundwater Treatment System* (BNL 2008c).

3.2.10.2 Groundwater Monitoring

Well Network

The monitoring network consists of 53 wells. There are 18 wells associated with the LIPA Upper Glacial portion of the plume that were installed to monitor the VOC plume off site, south of the OU III Industrial Park System. The Airport System network has 29 monitoring wells, which monitor the portions of the plume south of the LIPA and the North Street systems. The Magothy extraction well on Stratler Drive has six monitoring wells associated with its operation. All of these wells are used to monitor and evaluate the effectiveness and progress of the cleanup associated with these three components of the system. **Figure 1-2** and **3.2.10-1** identify the monitoring wells for these plumes.

Sampling Frequency and Analysis

The monitoring wells for LIPA are currently on a quarterly and semiannual sampling schedule for VOCs. The Airport wells are sampled quarterly (**Table 1-5**).

3.2.10.3 Monitoring Well Results

The primary VOCs associated with these portions of the plume are carbon tetrachloride, TCA, TCE, and 1,1-dichloroethylene. Groundwater monitoring for these systems was initiated in 2004. Fourth-quarter 2009 well data are posted on **Figures 3.2-1, 3.2.10-1** and **3.2.10-2**. The complete analytical results are in **Appendix C.** Results for key monitoring wells and extraction wells are as follow:

- During 2009 TVOC concentrations for the Magothy extraction well EW-4L on Stratler Drive ranged from 38 µg/L in January to 26 µg/L in October. Carbon tetrachloride is the primary VOC detected in this well. The Magothy monitoring wells associated with this portion of the plume show concentrations below 50 µg/L TVOCs, with well 000-130 showing the highest concentration (30 µg/L) in May 2009. **Figure 3.2.10-3** plots the TVOC influent trends for the LIPA extraction wells.
- Two of the three Upper Glacial LIPA extraction wells, EW-1L and EW-3L, were shut down in October 2007. Well EW-2L had a high TVOC concentration of 10 µg/L in January and a low of 8 µg/L in October 2009. Well EW-3L continued to show VOC concentrations below AWQS. EW-1L showed TVOC concentrations ranging from 9 µg/L in January to 6 µg/L in October 2009. The capture goal of the LIPA extraction wells is 50 µg/L TVOCs.
- VOC concentrations in monitoring wells near the Airport System extraction wells are below AWQS, except for well 800-96. However, upgradient monitoring wells 800-94 and 800-95, approximately 1,500 feet north of wells RTW-1A and RTW-2A, have historically shown TVOC concentrations primarily composed of carbon tetrachloride ranging up to 100 µg/L. The concentrations were 13 µg/L and 32 µg/L in November 2009.
- Five of the six airport extraction wells had VOC concentrations below AWQS throughout 2009. Newly installed extraction well RW-6A showed TVOC concentrations of 10 µg/L in January to 14 µg/L in July.
- Well 800-96 was installed as a western perimeter monitoring well for extraction well RTW-1A. Sampling of this well began in March 2004. No detections of carbon tetrachloride were found in this well until December 2005, when it was detected at 1.6 µg/L. In June 2006, 10 µg/L of carbon tetrachloride was detected in this well, and in August 2006 the concentration increased to 40 µg/L. Due to these VOC increases, the monitoring frequency for this well was changed from quarterly to monthly beginning in December 2006. During 2007 a new extraction well RW-6A and five new monitoring wells (800-126, 800-127, 800-128, 800-129, and 800-130) were installed to monitor and capture the contaminants in the vicinity of well 800-96 (**Figure 3.2.10-1**). Well 800-96 has had carbon tetrachloride concentrations up to 113 µg/L in February 2009 and to 47 µg/L in November 2009. None of the monitoring wells installed downgradient of this area have shown carbon tetrachloride above AWQS.
- As per recommendation in last year's annual report, in February 2009 a vertical profile well (APVP-1-2009) was installed about 200 feet west of well RTW-3A to bound the western edge of the plume in this area. The vertical profile showed low concentrations of TCA (1.3 µg/L at 215 and 225 ft bls). **Table 3.2.10-3** summarizes the vertical profile data. In March 2009, a permanent monitoring well was installed at this location (800-133) that is screened from 215 to 235 ft bls (**Figure 3.2.10-1**). This well has low concentrations of VOCs below the AWQS.

3.2.10.4 System Operations

In 2009, the extraction wells were sampled once per month. The influent, midpoint, and effluent of the carbon units were sampled two times per month. All System samples were analyzed for VOCs. The Airport extraction wells are on a pulse-pumped schedule, being pumped one week per month, except for wells RTW-1A and RW-6A which are pumped on a full-time basis. RW-6A began full-time operations in September 2008.

The following is a summary of the OU III Airport/LIPA System operations for 2009.

January – September 2009

The LIPA System was down in January for a carbon change out and communication problems between the LIPA vault and the Airport system. In September the system was down due to a communication problem. The Airport wells continued normal operations, with wells RTW-1A and RW-6A operating on a full-time basis. RTW-3A which had temporarily operated on a full-time basis due to a sample round showing concentrations above 10 µg/L stopped full-time operations in October 2009.

October – December 2009

The system operated normally for the last quarter of 2009 with minimal down time due to scheduled maintenance and carbon change-outs.

Extraction Wells Operational Data

During 2009, approximately 266 million gallons were pumped and treated by the OU III Airport/LIPA System, with an average flow rate of 514 gpm (**Table 3.2.10-2). Table F-37** summarizes the system's mass removal. VOC concentrations for the airport and LIPA extractions wells are provided on **Table F-38.**

3.2.10.5 System Operational Data

System Influent and Effluent

VOC concentrations for the carbon influent and effluent in 2009 are summarized on **Tables F-39** and **F-40.**

The carbon vessels for the system effectively removed the contaminants from the influent groundwater. 2009 System effluent data were below the analytical below the regulatory limit specified in the SPDES equivalency permit. **(Table 3.2.10-1).**

Cumulative Mass Removal

The mass of VOCs removed from the aquifer by the OU III Airport/LIPA Treatment System was calculated using the average flow rates for each monitoring period (**Table F-37**) in combination with the TVOC concentration in the carbon unit's influent, to calculate the pounds per month removed. The plot of cumulative mass of VOCs removed vs. time (**Figure 3.2.10-4**) shows that 23 pounds of VOCs were removed during 2009, with a total of 283 pounds removed since system start-up.

3.2.10.6 System Evaluation

The Airport Treatment System was designed to capture the leading edge of the OU III and OUI/IV VOC plumes. The newly installed extraction well (RW-6A) has shown carbon tetrachloride above AWQS since it was installed and began operations in November 2007. Some higher concentrations of VOCs have been detected upgradient of these wells. VOC concentrations in the LIPA wells are consistent with the groundwater modeling performed for the design of this system. **Table 3.2.10-1** shows maximum measured values and the values allowed under the SPDES equivalency permit.

The OU III Airport/LIPA system performance can be evaluated based on the five major decision rules identified for this system

Table 3.2.10-1
OU III LIPA/Airport Pump & Treat System
2009 SPDES Equivalency Permit Levels

Parameters	Permit Level (µg/L)	Max. Measured Value (µg/L)
pH	5.5–7.5 SU	5.8-7.45 SU
carbon tetrachloride	5	ND
chloroform 7		ND
1,1-dichloroethane	5	ND
1,1-dichloroethylene 5		ND
methylene chloride	5	0.62
1,1,1-trichloroethane 5		ND
trichloroethylene	10	ND

Notes:
ND = Not detected above method detection limit of 0.50 µg/L.
Sampling required an a monthly basis

resulting from the groundwater DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?
No, there were no unusual or unexpected VOC concentrations observed in the monitoring wells of the LIPA/Airport Treatment System during 2008.

2. Has the plume been controlled?
Yes, based on the historical analytical data collected from the monitoring wells and the results of the *LIPA/Airport Pump Test Report* (Holzmacher 2004), the plumes are being controlled. The capture zones (**Figure 3.0-1**) clearly show that the capture goal of 50 µg/L TVOC at the LIPA Upper Glacial and Magothy wells is being met. The leading edge of the plume has reached the airport.

3. Is the system operating as planned? Specifically, is the aquifer being restored at the planned rate?
Yes, the system is operating as planned.

4. Can the groundwater treatment system be shut down?
No, the system has not met all shutdown requirements (see below).

4a. Have asymptotic TVOC concentrations been reached in core wells?
No, asymptotic concentrations have not been reached.

4b. Is the TVOC concentration in the LIPA core wells less than 50 µg/L?
Yes;

4c. Are the TVOC concentrations in the Airport core wells less than 10 µg/L ?
No, seven airport core wells (800-63, 800-92, 800-94, 800-95, 800-96, 800-101, and 800-106) had TVOC concentrations greater than 10 µg/L in 2009.

4d. During pulsed operation of the system, is there significant concentration rebound in core wells?
The intent of the current pulse pumping at the Airport is not to evaluate for rebound but to monitor for the high-concentration segment currently located north of the Airport as it continues to travel south toward the northern perimeter of the Airport extraction wells.

5. Have the groundwater cleanup goals been met? Have MCLs been achieved?
No, the cleanup goals have not been met. Based on model results, MCLs are expected to be achieved by 2030 for the Upper Glacial aquifer, and in the Magothy aquifer by 2065, as required by the OU III ROD and ESD.

3.2.10.7 Recommendations

The following recommendations are made for the LIPA/Airport Pump and Treat System and groundwater monitoring program:

- Continue the airport extraction wells pulse-pumping schedule of pumping one week per month except for wells RTW-1A and RW-6A, which will continue with full-time operations. If concentrations above the capture goal of 10 µg/L TVOCs are observed in any of the extraction wells or the monitoring wells adjacent to them, the well(s) will be put back into full-time operation.
- Maintain LIPA wells EW-1L and EW-3L in standby mode. These extraction wells will be restarted if TVOC concentrations rebound above the 50 µg/L capture goal in either the plume core monitoring wells or the extraction wells.

- Place LIPA Well EW-2 in standby, as this well was below AWQS throughout 2009.

This page intentionally left blank.

3.2.11 Magothy Aquifer

This section provides a brief summary of the Magothy Aquifer Groundwater Monitoring Program and the remedial approach for addressing the VOC contamination. The 41 monitoring wells used to characterize the Magothy are shown on **Figure 3.2.11-1**.

Detailed descriptions of the monitoring well analytical results and remediation progress are presented in the following sections of this report: Western South Boundary, Middle Road, Airport/LIPA, North Street, North Street East, OU III South Boundary, Industrial Park and Industrial Park East. A brief summary of the results is provided on **Table 3.2.11-1**. Further details about these characterization results are in the *Final Magothy Aquifer Characterization Report* (Arcadis Geraghty & Miller 2003).

Table 3.2.11-1. Magothy Aquifer Contamination (Historical and 2009).

	Max. TVOC (in µg/L)			
Location	2009	Historical	Primary VOCs	Results
Western Boundary on site	<5.0	<5.0	None	Magothy not impacted. Two monitoring wells serve as adequate outpost/sentinel wells for Suffolk County Water Authority William Floyd Well Field.
Middle Road and South Boundary on site	113	340	PCE, CCl_4	VOCs identified in upper 20 to 40 feet of Magothy at Middle Road area where brown clay is absent. A temporary well installed in 2006 did not detect Magothy contamination between the Middle Road and South Boundary. VOCs not detected at South Boundary beneath the clay.
North Street off site	102	102	TCE	VOC concentrations have been detected in localized areas in the upper 30 feet of the Magothy aquifer and downgradient near Vita Drive. Leading edge of contamination is around Moriches-Middle Island Road.
North Street East off site	11	30	1,1-DCA; 1,1-DCE	Low VOC concentrations have been detected at the BNL south boundary to North Street below the brown clay at approximately 40 to 150 feet into the upper Magothy.
Industrial Park East off site and south boundary	31	570	TCA, CCl_4	TVOC concentrations currently are less than 60 µg/L off site in the Industrial Park, where brown clay is absent. Magothy and Upper Glacial contamination is contiguous in Industrial Park.
South of Carleton Drive off site	31	7,200	CCl_4	Historically high VOC concentrations just south of Carleton Drive where brown clay is absent. Levels of TVOCs are now less than 50 µg/L. Contamination is contiguous between Magothy and Upper Glacial aquifer.

The Magothy Remedy identified in the *Explanation of Significant Differences* (ESD) document calls for the following:

1. Continued operation of the five extraction wells as part of the Upper Glacial treatment systems that provide capture of Magothy VOC contamination (Middle Road, South Boundary [currently in standby], Airport, Industrial Park East [currently in standby], and LIPA).

2. Continued evaluation of monitoring well data to ensure protectiveness. **Table 3.2.11-2** describes how each of the Magothy investigation areas is addressed by the DOE's selected Magothy aquifer remedy.
3. Institutional controls and five-year reviews.

Data for all Magothy monitoring wells are presented in **Appendix C.**

Table 3.2.11-2. Magothy Remedy.

Area Investigated	Selected Remedy
Western boundary on-site area	Continue monitoring and evaluate data.
Middle Road and South Boundary on-site area	Continue operation of the Magothy extraction well at Middle Road, as well as the two Upper Glacial systems. Continue to monitor the three Magothy monitoring wells at Middle Road and three at the south boundary until cleanup goals are met.
North Street off-site area	Continue operation of the two existing Upper Glacial extraction wells on Sleepy Hollow Drive and North Street until cleanup objectives are met. Continue monitoring and evaluate data.
North Street East off-site area	Continue monitoring and evaluate data.
Industrial Park East off-site area and s. boundary	Continue operation of the Industrial Park East Magothy extraction well until cleanup objectives are achieved (this well is currently in standby as cleanup goals have been met). Continue monitoring and evaluate data.
South of Carlton Drive off-site area	Continue operation of the LIPA Magothy extraction well on Stratler Drive until cleanup goals are achieved. This will capture high concentrations of VOCs identified on Carleton Drive and prevent migration of high concentrations of VOCs through the hole in the brown clay and into the Magothy aquifer. Continue monitoring and data evaluation.

3.2.11.1 Monitoring Well Results

There are 41 monitoring wells in the Magothy monitoring program (**Figure 3.2.11-1**). **Figure 3.2.11-2** shows trend plots of several of the key monitoring wells. A discussion of some of the key wells follows.

Well 000-130: This well is on Carleton Drive and has historically had the highest concentrations of carbon tetrachloride observed off site related to BNL: over 7,000 µg/L. Concentrations of TVOC concentrations ranged from 15 µg/L to 31 µg/L in 2009. The higher concentrations of carbon tetrachloride observed historically in this well are being captured by the LIPA extraction well on Stratler Drive. A more detailed discussion of this is available in **Section 3.2.10**, LIPA/Airport Pump and Treat System.

Wells 000-249 and 000-250: These wells are in the Industrial Park near well UVB-1. Well 000-249 had TVOC concentrations ranging from 44 µg/L in August to 11µg/L in November 2009. Well 000-250 had VOC concentrations below AWQS in 2009. Based on analytical data, the higher levels of contamination observed in well 000-249 are being captured by the UVB wells, even though 000-249 is on the edge of the capture zone for these wells. Any contaminants above the capture goal of 50 µg/L TVOC that migrate beyond the capture zone of this system will be captured by the Stratler Drive extraction well.

Wells 000-425 and 000-460: These wells are adjacent to the LIPA Stratler Drive Magothy extraction well. Well 000-425 had concentrations of TVOCs ranging from 5 µg/L to 10 µg/L during 2009. This well is immediately adjacent to the extraction well. Well 000-460, located east of the extraction well but within the capture zone, had concentrations ranging from 0.3 to 10 µg/L in 2009.

Well 122-05: This well, located at the eastern edge of the OU III South Boundary System, showed TVOC concentrations at approximately 30 µg/L in 2009.

Well 000-343: Located south and between the OU I and OU III South Boundary systems, this well had TVOC concentrations around 10 µg/L in 2009.

Well 115-50: Located south and between the OU I and OU III South Boundary systems, this well had VOC concentrations below AWQS in 2009.

Wells 000-427 and 000-429: These wells are located just south of the Industrial Park East System on Carleton Drive. In 2009, well 000-427 had TVOC concentrations ranging from 3 µg/L to 12 µg/L and well 000-429 had concentrations ranging from 3 µg/L to 7 µg/L in 2009.

Well 800-90: This well is located near Moriches-Middle Island Road upgradient of Airport extraction wells RTW-3 and RTW-4. It is screened at approximately 255 feet below grade. TVOC concentrations ranged from 62 µg/L to 102 µg/L in 2009. This is indicative of contamination that was already past the North Street extraction wells prior to operation, and will eventually be captured by the Airport extraction wells RTW-3 and RTW-4.

Well 113-09: This well is located at the Middle Road west of extraction well RW-1. It is screened near the Upper Glacial/Magothy interface at 220 feet. It has shown TVOC concentrations of 94 µg/L in October 2009. Concentrations have been stable for the past few years in this well.

3.2.11.2 Recommendations

No changes to the Magothy groundwater monitoring program are warranted at this time. Continue the current monitoring schedule for the Magothy monitoring program. The IPE and South Boundary Magothy extraction wells are currently in standby as they have reached the cleanup goals (TVOC <50 µg/L) identified for shutdown of these wells.

This page intentionally left blank.

3.2.12 Central Monitoring

The OU III Remedial Investigation (RI) identified several low-level (less than 50 µg/L) TVOC source areas and nonpoint contaminant sources within the developed central areas of the BNL site. These sources include spills within the Alternating Gradient Synchrotron (AGS) Complex, the Bubble Chamber spill areas, and the Building 208 vapor degreaser. Because these sources are not large enough to warrant a dedicated monitoring program, they are monitored under the OU III Central Monitoring Program. In addition, this program includes wells 109-03 and 109-04, located near the BNL western site boundary. These wells were installed by the SCDHS to serve as sentinel wells for the SCWA William Floyd Parkway Well Field.

3.2.12.1 Groundwater Monitoring

Well Network

The monitoring well network is comprised of 13 wells (**Figure 3.2.12-1**). The well locations aid in defining the VOC plumes that extend downgradient from the central areas of the site. This network is also supplemented by data from Facility Monitoring program wells that monitor active research and support facilities (**Table 1-6**). Results from the Environmental Surveillance (ES) programs are provided in **Section 4**.

Sampling Frequency and Analysis

The wells are sampled and analyzed annually for VOCs, and wells 109-03 and 109-04 are analyzed quarterly for VOCs, gamma spectroscopy, tritium, and Sr-90 (**Table 1-5**).

3.2.12.2 Monitoring Well Results

Only two VOCs were detected in the OU III Central wells above NYS AWQS. Well 065-02 had a TCA concentration of 9.3 µg/L and Well 076-317 had a PCE concentration of 12 µg/L, which are both above the NYS AWQS of 5 µg/L for each compound. In many of the wells in the north-central developed portion of the site, the primary constituent is TCA. SCDHS wells 109-03 and 109-04 serve as sentinel wells for the SCWA William Floyd Well Field and are near the western BNL property boundary. There were no detections of VOCs above the NYS AWQS during 2009. Radionuclides were not detected in any of the samples collected from wells 109-03 and 109-04 during 2009.

Due to access issues caused by the construction at the National Synchronous Light Source II site, well 096-07 could not be sampled.

3.2.12.3 Groundwater Monitoring Program Evaluation

The evaluation of the OU III Central Monitoring Program is based on four major decision rules established for this program using the groundwater DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?

No. There were no unusual or unexpected VOC or radionuclide concentrations in the monitoring wells associated with this program during 2009.

2. Are there potential impacts to the SCWA William Floyd Well Field from on-site contamination?

No. There were no detections of contaminants in the sentinel monitoring wells during 2009, with the exception of low-level (below 0.5 ug/L) chlorinated organic compounds (below NYS AWQS). These compounds were chloroform, methyl chloride, and methylene chloride.

3. Are the performance objectives met?

No. Since 1997, the VOC concentrations in the central portion of the site have significantly decreased, as noted in TVOC plume comparison **Figure 3.2-3**. However, during 2009 several individual wells continued to contain VOC concentrations exceeding the NYS AWQS; therefore, the OU III ROD objective of meeting MCLs by 2030 has not yet been met.

4. If not, are observed conditions consistent with the attenuation model?
Yes. The observed VOC concentrations generally agree with the model-predicted concentrations, with respect to both the plume extent and contaminant concentrations.

3.2.12.4 Recommendation

No changes to the OU III Central groundwater monitoring program are warranted at this time.

3.2.13 Off-Site Monitoring

The OU III Off-Site Groundwater Monitoring Program consists of 12 wells. They were installed to monitor contamination in the southwest portion of the OU III plume or they were installed as part of the early BNL hydrogeologic characterization.

3.2.13.1 Groundwater Monitoring

Well Network

The network has 12 wells that monitor the off-site southwest downgradient extent of the OU III VOC plumes (**Figure 1-2** and **3.2.13-1**). Some wells downgradient of the leading edge of the plumes serve as sentinel wells. These wells are screened in the deep portions of the Upper Glacial aquifer.

*Sampling Frequency and Analysi*s

The wells were sampled annually and samples analyzed for VOCs (**Table 1-5**). Samples were collected in the fourth quarter of 2009.

3.2.13.2 Monitoring Well Results

The complete results for the monitoring wells in this program can be found in **Appendix C**. The horizontal extent of the off-site segment of the OU III VOC plume is shown on **Figure 3.2-1**.

The monitoring wells in the OU III Off-Site Monitoring Program are perimeter and sentinel wells. In 2009, they continued to have VOC concentrations below the NYS AWQS. Chloroform was detected at up to 2.1 µg/L in well 000-98 during November 2009. 1,1,1-Trichloroethane was detected at 1.7 µg/L and Trichloroethylene was detected at 1.4 µg/L in well 800-52 during November 2009.

3.2.13.3 Groundwater Monitoring Program Evaluation

There were no unexpected results during 2009 that would have triggered the BNL Groundwater Contingency Plan. All VOC detections were below NYS AWQS.

3.2.13.4 Recommendation

No changes to the OU III Off-Site Groundwater Monitoring Program are warranted at this time.

This page intentionally left blank.

3.2.14 South Boundary Radionuclide Monitoring Program

The South Boundary Radionuclide Monitoring Program was initiated to confirm that groundwater impacted by radionuclides is not currently migrating off the south section of the BNL site. The sampling was conducted in conjunction with the OU III South Boundary, Western South Boundary, and OU VI Programs. The eastern portions of the site south boundary are monitored for radionuclides as part of the OU I South Boundary and OU V STP groundwater monitoring programs.

3.2.14.1 Groundwater Monitoring

A network of 56 monitoring wells is used to monitor radionuclides from the OU III South Boundary, OU III Western South Boundary, and OU VI programs. The well locations along the southern property boundary are shown on **Figure 3.2.14-1**.

Sampling Frequency and Analysis

The OU III South Boundary Radionuclide Monitoring Program wells were sampled annually for tritium, Sr-90, and gamma spectroscopy (**Table 1-5**).

3.2.14.2 Monitoring Well Results

The radionuclide analytical results for the wells can be found in **Appendix C**. There were no confirmed radionuclide detections during 2009.

3.2.14.3 Groundwater Monitoring Program Evaluation

The OU III South Boundary Radionuclide Monitoring Program can be evaluated based on the decision rule identified for this program resulting from applying the groundwater DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?

No. There were no unexpected results during 2009 to trigger the BNL Groundwater Contingency Plan.

3.2.14.4 Recommendations

The following are the recommendations for the South Boundary Radionuclide groundwater monitoring program:

- Since there are wells directly upgradient of monitoring wells 121-43, 122-24, 122-25, 122-34, and 122-35 and there have been no radionuclide detections reported, sampling of these wells for radionuclides should be discontinued.

.

This page intentionally left blank.

3.2.15 BGRR/WCF Strontium-90 Treatment System

The OU III Brookhaven Graphite Research Reactor (BGRR)/Waste Concentration Facility (WCF) Treatment System addresses the Sr-90 plumes in groundwater downgradient of these facilities. Some of the wells included in the OU III BGRR/WCF network are also monitored for tritium for the g-2 plume (**Sections 3.2.17** and **4.11**). These wells are sampled concurrently for all of these programs to avoid duplication of effort. The BGRR/WCF remedy consists of:

1. Operation of five extraction wells using ion exchange to remove Sr-90, with on-site discharge of the clean water to dry wells
2. Operation of the system to minimize plume growth and meet DWS by 2070
3. Continued monitoring and evaluation of data to ensure protectiveness
4. Institutional controls and five-year reviews

The analytical results indicate three areas of elevated Sr-90: one extending south from the WCF area, one extending south of the BGRR Below Ground Ducts (BGD) and former Canal House, and one that is south of the former Pile Fan Sump (PFS) area (**Figure 3.2.15-1**).

3.2.15.1 System Description

System operations for this treatment system began in January 2005. There are two extraction wells (SR-1 and SR-2) located south of the WCF and three extraction wells (SR-3, SR-4, and SR-5) located south of the BGRR. The treatment system typically operates at an average rate of 25 gpm total from the five extraction wells.

Groundwater from the five extraction wells is transported through pipelines to an ion exchange treatment system inside Building 855 (within the BNL Waste Management Facility). The vessels of ion exchange media are designed to treat groundwater contaminated with Sr-90 to below the 8 pCi/L DWS. In addition, the influent is also treated for low-level concentrations (less than 10 µg/L) of TVOCs using liquid-phase activated carbon.

Effluent is recharged to the Upper Glacial aquifer via three drywells located approximately 850 feet west of Building 855. A SPDES equivalency permit regulates this discharge. A complete description of the system is included in the *Operations and Maintenance Manual for the Sr-90 BGRR/WCF/PFS Groundwater Treatment System* (BNL 2005d).

3.2.15.2 Groundwater Monitoring

Well Network

A network of 84 monitoring wells is used to monitor the Sr-90 plumes associated with the BGRR, WCF, and PFS areas. This network is currently being supplemented with temporary wells in the vicinity of the HFBR to monitor the high concentration Sr-90 and tritium (g-2) plume identified in this area in 2007 through 2009. Most recently, temporary wells were installed in this area during the fourth quarter of 2009 and the first quarter of 2010.

Sampling Frequency and Analysis

In 2009, the sampling frequency for all three of the Sr-90 plume segments, (BGRR, PFS and WCF) is in the O&M phase (annual) for most wells. The well samples are analyzed for Sr-90. As noted on **Table 1-5,** wells also serve dual purposes for other programs.

3.2.15.3 Monitoring Well/Temporary Well Results

The Sr-90 plume distribution map is shown on **Figure 3.2.15-1**. The distribution of Sr-90 throughout the BGRR, WCF, and PFS areas is depicted based on groundwater data obtained from the fourth-quarter 2009 and first-quarter 2010 sampling of the permanent and temporary wells. The following cross-sectional views are also provided:

- **Figure 3.2.15-2** (I–I') for the BGRR plume – A north–south cross section from the BGRR south to Brookhaven Avenue
- **Figure 3.2.15-3** (J–J') for the PFS plume – A north–south cross section from Building 801 south to Cornell Avenue
- **Figure 3.2.15-4** (K–K') for the WCF plume – A north–south cross section from WCF south to Cornell Avenue

In addition, historical Sr-90 concentration trend plots for key wells are plotted on **Figure 3.2.15-5**.

Historically, the highest overall Sr-90 concentration (3,150 pCi/L) occurred in 2003 in a temporary well installed approximately 200 feet south of Building 701 and slightly upgradient of the current location of extraction well SR-3. The highest historical Sr-90 concentration in the WCF area (1,560 pCi/L) occurred in April 2003 in a temporary well installed immediately downgradient of the six former underground storage tanks (USTs A/B) and approximately 25 feet north of the WCF (Building 811). This area within the WCF is upgradient of the current location of extraction well SR-1. The highest historical Sr-90 concentration in the former PFS area (566 pCi/L) occurred in March 1997 in a temporary well installed downgradient of the PFS.

The following is a summary of the monitoring data for the three Sr-90 plumes.

WCF Plume

Refer to **Figure 3.2.15-4** for a cross-sectional view of the WCF plume.

- In 2009, the highest Sr-90 concentration in the source area for this plume was 371 pCi/L in plume core well 065-175, located immediately south of the WCF yard. The historical high for this well was 821 pCi/L in 2000. **Figure 3.2.15-5** shows fluctuating Sr-90 concentrations with no significant trend in this well over the past nine years. This contamination is captured by extraction well SR-2.

- As recommended in the *2008 BNL Groundwater Status Report* (BNL 2008b), select samples were analyzed for Sr-90 during the installation of temporary wells to characterize the g-2 tritium plume just south of the HFBR. The cross section on **Figure 3.2.15-4** shows both plumes and illustrates the relationship between the two plumes. The data from this effort is being used to design the array of additional Sr-90 extraction wells necessary to remediate the high Sr-90 concentrations and enable the OU III ROD cleanup goals to be achieved. From February through March 2010, two sets of east-west temporary well transects were installed and sampled for both tritium and Sr-90. The six temporary well locations (i.e., g-2-GP-#) are identified on **Figure 3.2.15-1** and the complete data set is available on **Table 3.2.15-1**. The Sr-90 data did not show any appreciable change in the downgradient portion of the WCF plume during 2009. The latest data does show that the g-2 tritium plume high concentration slug has continued to migrate south. Based on this data there are no longer tritium concentrations exceeding the DWS in the area adjacent to the HFBR currently being targeted for additional Sr-90 extraction wells.

BGRR Plume

Refer to **Figure 3.2.15-2** for a cross-sectional view of the BGRR plume. The monitoring well data for this plume was supplemented with nine temporary wells in 2009 as per the recommendation from the *2008 BNL Groundwater Status Report*.

- Temporary well GP-36 was installed immediately adjacent to monitoring well 075-664. The purpose of this well was to determine if the screen zone in the permanent well was too far below the water table to intercept high concentrations of Sr-90 still migrating from the BGD and Building 701 area. The results from GP-36 (peak Sr-90 concentration of 592 pCi/L at the water table) as compared to the results from well 075-664 (14 pCi/L) confirmed that in fact the permanent well is screened too deep. The results also confirm a continuing source of Sr-90 contamination from the BGD/Building 701. The high Sr-90 concentrations in this area are captured by extraction well SR-3.
- Temporary well GP-37 results indicate that the plume center-line at Cornell Avenue is to the east of well cluster 075-190, 075-191, and 075-192. Extensive underground utilities preclude monitoring the plume center-line in this area.
- A higher than expected Sr-90 detection at well 075-671 (located on Brookhaven Avenue) of 82 pCi/L in October of 2009 prompted the installation of seven additional temporary wells from just south of Cornell Avenue to south of Brookhaven Avenue. This concentration was in the upper range of concentrations that could be expected in this area based on the system design groundwater modeling. Three temporary wells adjacent to this monitoring well showed a maximum concentration of 54 pCi/L. In addition, in a subsequent sampling during the first quarter of 2010 the concentration in 075-671 decreased to 29 pCi/L. Two additional temporary wells were installed approximately 150 feet south of Brookhaven Avenue and showed a maximum Sr-90 concentration of 12 pCi/L(GP-44).
- Following the Sr-90 detection at well 075-671 additional temporary wells (GP-39 and GP-38) were installed at locations between Cornell and Brookhaven Avenue where there are no current monitoring points. The data from these temporary wells showed levels of Sr-90 that were within the expected range of concentrations for this segment of the plume.

Pile Fan Sump Plume

Refer to **Figure 3.2.15-3** for a cross-sectional view of the Pile-Fan Sump plume

- As recommended in the *2008 Groundwater Status Report* (BNL 2008b), a temporary well (GP-43) was installed just north of well 075-86. The purpose of this well was to determine whether the screen zones of the well cluster 075-46, 075-85, 075-86, and 075-672 were spaced appropriately to intercept and characterize the plume center-line. The high concentration for GP-43 was 57 pCi/L at 82 feet bls which is located in a gap within the screen zones at this well cluster (**Table 3.2.15-1**). This data correlates with monitoring well 075-683 (located approximately 50 feet east) which is screened from 79 to 84 feet bls and also had a concentration of 58 pCi/L of Sr-90 (**Figure 3.2.15-3)**.
- Plume core well 065-37, located just downgradient of the PFS, detected 52 pCi/L Sr-90 in October 2009. As noted on **Figure 3.2.15-5**, this is a slight decrease from the 2007 data but steady from prior year data.

3.2.15.4 System Operations

In accordance with the SPDES equivalency permit, the required frequency for Sr-90 and VOC sampling is monthly and the pH measurement is weekly. However, throughout 2009 while the system was operating, samples from the influent, effluent, and midpoint locations of the treatment system were collected twice a month in order to optimize resin usage. All system samples were analyzed for Sr-90 and VOCs. The influent was also analyzed for tritium, and both the influent and effluent were analyzed weekly for pH. Sr-90 concentrations for the extraction wells in 2009 are summarized on **Table F-40**. System influent and effluent concentrations are summarized on **Tables F-41** and **F-42**. **Table F-43** contains the monthly Sr-90 removal totals for the system.

Operating details are given in the O&M manual for this system (BNL 2005d). Below is a summary of the system operations for 2009.

January – September 2009

The system was off from February 23 to March 23 for a resin vessel change out. In July the system was off for ten days for a piping re-configuration. In addition in July and part of August, wells SR-1 and SR-2 were shutdown for a week while the A/B waste line excavation work took place. Well SR-3 was off for most of the month of August with electrical problems. The system was also off for most of September while maintenance was being performed. The system pumped a total of 6.5 million gallons for this period.

October – December 2009

SR-3 and SR-5 were off for part of the month of October with electrical problems. Well SR-5 was also off for part of November due to this problem. The system operated normally the remainder of the time and pumped a total 2 million gallons for this period.

Extraction Well Operational Data

During 2009, approximately 8.5 million gallons were pumped and recharged by the OU III BGRR/WCF SR-90 Treatment System, with an average flow rate, including maintenance down time, of 17 gpm. **Table 3.2.15-3** shows the monthly extraction well pumping rates while **Table F-40** shows Sr-90 concentrations.

Table 3.2.15-2
BGRR Sr-90 Treatment System
2009 SPDES Equivalency Permit Levels

Parameter	Permit Level	Max. Measured Value
pH range	5.5–8.5 SU	5.8–7.7 SU
Sr-90	8.0 pCi/L	1.72
Chloroform	7.0 µg/L	<0.5
1,1-Dichloroethane 5.0	µg/L	<0.5
Ethylbenzene 5.0	µg/L	<0.5
Methyl Chloride	5.0 µg/L	<0.5
Methylene Chloride	5.0 µg/L	<0.5
Toluene 5.0	µg/L	<0.5
1,2,3-Trichlorobenzene	5.0 µg/L	<0.5
1,1,1-Trichloroethane 5.0	µg/L	<0.6
1,2,4-Trimethylbenzene	5.0 µg/L	<0.5
Xylene, total	10.0 µg/L	<0.5

Notes:
ND = Not detected above minimum detectable activity.
SU = Standard Units
Required sampling frequency is monthly for Sr-90 and VOCs, and weekly for pH.

3.2.15.5 System Operational Data

During 2009, influent concentrations of Sr-90 ranged from 21 to 54 pCi/L, with the highest concentration observed in March. The highest influent tritium concentration during 2009 was 353 pCi/L in November (**Table F-41**). During 2009, Sr-90 was detected three times in the effluent samples in January, February and December, at concentrations of 1.7, 1.6 and 0.78 pCi/L respectively (**Table F-42**). These detections were below the limit of 8.0 pCi/L (**Table 3.2.15-2**). There were no VOCs detected above the SPDES Equivalency Permit discharge limits in the 2009 influent or effluent samples.

Cumulative Mass Removal

Average flow rates for each monitoring period were used, in combination with the Sr-90 influent concentrations, to calculate the number of milliCuries (mCi) removed. During 2009, the flow averaged 17 gpm. Approximately 1.4 mCi of Sr-90 was removed during 2009, for a total of 17.5 mCi removed since system start-up in 2005 (**Table F-43**). Cumulative mass removal of Sr-90 is shown on **Figure 3.2.15-6**.

Extraction Wells

Maximum Sr-90 concentrations in each of the extraction wells during 2009 were as follows:

- SR-1 60 pCi/L in July
- SR-2 98 pCi/L in April
- SR-3 89 pCi/L in November
- SR-4 15 pCi/L in July
- SR-5 52 pCi/L in July

During 2009, no VOCs were detected above the drinking water standard in the extraction wells. **Figures 3.2.15-7** and **3.2.15-8** shows the influent Sr-90 concentrations for individual extraction wells over time.

3.2.15.6 System Evaluation

The OU III BGRR/WCF Strontium-90 Groundwater Treatment System and Monitoring Program can be evaluated in the context of four basic decisions established for this program using the groundwater DQO process:

1. Was the BNL Groundwater Contingency Plan triggered?

WCF Plume: No. There were no unusual or unexpected concentrations in the monitoring wells associated with this program during 2009.

BGRR Plume: Yes. Sr-90 was detected at a higher than expected concentration of 82 pCi/L at well 075-671 (located on Brookhaven Avenue) in October of 2009.

PFS Plume: No. There were no unusual or unexpected concentrations in the monitoring wells associated with this program during 2009.

2. Has the plume been controlled?

WCF Plume: The source area is controlled by extraction wells SR-1 and SR-2 although monitoring well data indicates that there may be a continuing source. It has been determined that the higher concentration downgradient segment of the plume in the vicinity of the HFBR will have to be addressed with active remediation in order to achieve the OU III ROD ESD cleanup goals of meeting DWS by 2070.

BGRR Plume: Yes. Based on the monitoring well data and recent temporary well data, the high concentration portion of the plume is being captured by extraction wells SR-3, SR-4, and SR-5. Based on the concentrations in temporary well GP-36 there appears to be a continuing source from the BGD/Building 701 area.

PFS Plume: Yes. Based on the monitoring well data and recent temporary well data, the high concentration portion of the plume is expected to attenuate to below DWS by 2070.

3. *Is the system operating as planned? Specifically, is the aquifer being restored at the planned rate identified in the Explanation of Significant Differences to the OU III Record of Decision?*

WCF Plume: The hydraulic capture performance of SR-1 and SR-2 in the source area is operating as modeled in the system design. The system has been removing Sr-90 from the aquifer and the resin is effectively treating the Sr-90 to below DWS. However, based on current model projections on the long-term restoration of the aquifer, the elevated Sr-90 concentrations identified in the vicinity of the HFBR indicate that the OU III ROD ESD cleanup goal of meeting DWS by 2070 will not be met without active remediation of this area. Additional extraction wells will be installed during 2010 to reduce the high concentration slug (identified as part of the recent effort) to levels that will attenuate in accordance with the cleanup goal.

BGRR Plume: The hydraulic capture performance of the system is operating as modeled in the system design, and the system has been removing Sr-90 from the aquifer. The resin is effectively treating the Sr-90 to below DWS. Data from GP-36 indicates that there is a continuing source at the BGD/Building 701. Recent data from this plume will be used for an updated groundwater modeling simulation to confirm that downgradient concentrations are within the range that will allow for the plume to naturally attenuate to DWS as per the OU III ROD cleanup goal.

PFS Plume: Based on the Sr-90 concentrations detected in 2009, the plume is attenuating as projected.

4. *Have the cleanup goals been met? Can the groundwater treatment system be shut down?*

WCF Plume: No. The cleanup goal of meeting the DWS in the aquifer has not yet been met. However, the system is minimizing plume growth of the higher concentrations of Sr-90 near the WCF. Installation of additional pump and treat wells in the vicinity of the HFBR in 2010 will allow for the OU III ROD ESD cleanup goal to be achieved.

BGRR Plume: No. The cleanup goal of achieving the DWS in the aquifer has not been met, but the system is preventing and minimizing plume growth of the higher concentrations of Sr-90.

PFS Plume: No. The cleanup goal of meeting the DWS in the aquifer has not yet been met. The plume is not being actively remediated.

3.2.15.7 Recommendations

The following are recommendations for the BGRR/WCF Groundwater Treatment System and Monitoring Program:

- Implement the installation of four additional extraction wells during 2010 to address the Sr-90 hot spots identified in the WCF plume.
- Install several temporary wells to characterize Sr-90 concentrations in the WCF source area.
- For the BGRR Sr-90 plume, install sentinel wells on the south side of Brookhaven Avenue to monitor the leading edge of the plume.
- Characterize the width of the plume at the well 075-664 location and install a new permanent monitoring well for the BGRR Sr-90 plume adjacent to monitoring well 075-664 screened at a shallower depth.
- Install temporary wells at Brookhaven Avenue to characterize the leading edge of the Pile-Fan Sump plume.

3.2.16 Chemical/Animal Holes Strontium-90 Treatment System

This section summarizes the operational data from the OU III Chemical/Animal Holes Strontium-90 Treatment System for 2009, and gives conclusions and recommendations for future operation. This system began operation in February 2003.

3.2.16.1 System Description

The Chemical/Animal Holes were located in the south-central portion of the BNL property (**Figure 1-1 and 3.2.16-1**). The area consisted of 55 pits east of the Former Landfill that were used for the disposal of a variety of laboratory chemicals and animal remains. The buried waste was excavated in 1997. In 2009 the Sr-90 plume (as defined by the 8 pCi/L isocontour) was approximately 680 feet long and 75 feet wide, with a maximum thickness of 15 feet. It is approximately 22 to 45 feet below ground surface.

The elements of the Sr-90 remediation at the Chemical/Animal Holes are:

1. Three extraction wells pumping into an ion exchange treatment system to remove Sr-90 from the extracted groundwater, and on-site discharge of the clean water into two drywells.
2. Operation of the system to minimize plume growth and meet DWS by 2040.
3. Continued monitoring and evaluation of the data to ensure protectiveness.

Details of operations are provided in the *Chemical/Animal Holes Strontium-90 Groundwater Treatment System Operation and Maintenance Manual* (BNL 2008d).

3.2.16.2 Groundwater Monitoring

Well Network

The Chemical/Animal Holes monitoring network consists of 35 wells. **Figure 1-2** and **3.2.16-1** shows the monitoring well locations.

Sampling Frequency and Analysis

The monitoring wells are sampled in accordance with the O&M phase (semiannual and annual) frequency. Eleven of the 35 monitoring wells were sampled semiannually for Sr-90; the remaining wells were sampled annually. The eleven semiannually sampled wells are considered key plume core, perimeter or bypass detection wells to provide indications of plume changes.

3.2.16.3 Monitoring Well Results

Figure 3.2.16-1 shows the Sr-90 plume distribution. The plume depiction is derived from third quarter monitoring well data.

To date, the highest Sr-90 concentration observed in groundwater in this area was 4,720 pCi/L at well 106-99 in March 2005. The areas of higher concentrations (>100 pCi/L) occur in very narrow bands. The first is an area at and immediately upgradient of EW-1. The second area, approximately 20 feet wide, begins just south of the Princeton Avenue firebreak and continues south for approximately 250 feet just upgradient of EW-3.

A summary of key monitoring well data for 2009 follows:

- The highest Sr-90 concentration observed in 2009 was 562 pCi/L in plume core well 106-16 during the first quarter sampling. This well is approximately 50 feet upgradient of EW-1 and began to rebound in late 2006 following two previous years of lower values (<250 pCi/L). However, Sr-90 concentrations in plume core well 106-99, slightly downgradient of 106-16, have remained low over the past four years despite reaching a historical high concentration for the entire plume of 4,720 pCi/L in 2005.

- Plume core wells 106-103 and 106-105, located immediately downgradient of EW-1, only detected up to 3.2 pCi/L in 2009. This is the second year that a break in the plume downgradient of EW-1 was observed.
- Plume core well 106-49, located in the centerline of the plume approximately 170 feet downgradient of extraction well EW-1, detected Sr-90 at 42.1 pCi/L in January and 104 pCi/L in July 2009. The data for this well are the lowest since 1999. This indicates that EW-1 is controlling the northerly high concentration area of the plume and the trailing edge of the southerly segment of the plume continues to slowly move through this area. This is also supported by the declining trends in upgradient wells 106-103 and 106-105.
- Plume core well 106-125, approximately 100 feet downgradient of well 106-49 and just upgradient of EW-2, is picking up the leading edge of the higher concentration portion of the plume. This well detected 498 pCi/L of Sr-90 in October 2007 and dropped off to 38 pCi/L in July 2009. Plume core well 106-119, located upgradient of the southern-most extraction well EW-3 averaged approximately 20 pCi/L of Sr-90 during 2009.
- Plume perimeter well 106-48 has been showing average values of Sr-90 for the last two years of approximately 30 pCi/L **(Figure 3.2.16-2)**. The data continues to reflect slight shifting of the western portion of the plume south of Princeton Avenue. As part of the 2008 recommendations temporary well installations in this area are ongoing in early 2010.
- Plume perimeter well 106-50 continues to bound the plume to the east since it has been below the DWS since 2006.
- Bypass wells 106-120, 106-121, and 106-122 are approximately 100 feet south of EW-3. The only detection of Sr-90 in these wells was 1.6 pCi/L in July 2009 in well 106-122.

The complete monitoring results for all wells in this program are in **Appendix C**.

3.2.16.4 System Operations

The Chemical/Animal Holes Strontium-90 Treatment System influent, effluent, and midpoint locations were sampled once a week, and in October 2009 the sampling frequency was changed to twice per month. These samples were analyzed for Sr-90 and the influent and effluent samples were analyzed for pH on a monthly basis (**Table 3.2.16-1**). The SPDES Equivalency Permit was renewed in February 2008 and the Sr-90 sampling frequency was changed from weekly to monthly and remained so for 2009. All extraction wells are sampled monthly **Table F-44**. Extraction well EW-1 remained in a pulse-pumping mode for 2009. Sr-90 concentrations for the system influent and effluent in 2009 are summarized on **Tables F-45** and **F-46**. **Table F-47** contains a summary of the monthly Sr-90 mass removal for the system.

Summarized below are the system operations data for 2009. Details for this system are given in the O&M manual.

Table 3.2.16-1.
OU III Chemical/Animal Holes Sr-90 Treatment System
2009 SPDES Equivalency Permit Levels

Parameter	Permit Level	Max. Measured Value
pH range (SU)	5.0–8.5	5.2–7.2
Sr-90 (pCi/L)	8.0	1.8

Notes:
pCi/L = pico Curies per liter
SU = Standard Units
J = Estimated value
Required sampling frequencies are monthly for Sr-90 and pH.

January – September 2009

For this period the system operated the majority of the time. The system was off several days in January due to planned power outages for construction projects at BNL. The system was also off from February 1st to the 4th due to electrical problems. From January through September, the treatment system pumped a total of 4.8 million gallons of water.

October – December 2009

The system operated normally for this quarter, with the exception of being off for several weeks in November and December due to a resin vessel change-out. The system pumped and treated a total of 1.4 million gallons of water this period.

3.2.16.5 System Operational Data

Sr-90 concentrations in EW-2 and EW-3 have decreased as expected since these wells became operational in November 2007. Upon start-up, EW-2 detected up to 139 pCi/L of Sr-90 and the concentration had steadily dropped to an average of 15 pCi/L for most of 2009. However, in December EW-2 had a concentration of 64 pCi/L. When EW-3 became operational, concentrations were already low at 13 pCi/L and averaged approximately 6 pCi/L for 2009 with a high of 8 pCi/L for the year. Concentrations of Sr-90 spiked up and down several times in EW-1, but averaged approximately 60 pCi/L for the year. Concentrations ranged from a low of 30 pCi/L to a high of 100 pCi/L in 2009. The spikes may be attributable to pulse pumping. **Figure 3.2.16-3** presents the extraction well influent data over time. The 2009 analytical data show that influent Sr-90 concentrations ranged from 8.5 to 50 pCi/L. Effluent samples were well below the SPDES equivalency permit level of 8 pCi/L for Sr-90. Approximately 6.3 million gallons of groundwater were processed through the system during 2009.

Cumulative Mass Removal

Average flow rates for each monitoring period were used, in combination with the Sr-90 concentration, to calculate the mCi removed. Flow averaged 12 gpm during 2009. **Table 3.2.16-2** shows the monthly extraction well pumping rates. The cumulative total mass of Sr-90 removed was approximately 0.46 mCi during 2009, with a total of approximately 3.79 mCi removed since 2003 (**Figure 3.2.16-4**).

3.2.16.6 System Evaluation

The Chemical/Animal Holes Sr-90 Treatment System performance can be evaluated based on the four major decisions identified for this system as part of the DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?

No. There were no unusual or unexpected Sr-90 concentrations in the monitoring wells or extraction wells associated with the Chemical/Animal Holes Treatment System during 2009.

2. Has the plume been controlled?

The monitoring data indicate that the plume is controlled by the three extraction wells pumping at 6 gpm. Monitoring of the three plume bypass wells will continue to provide verification. The travel time from EW-3 to these wells is approximately three years (**Figure 3.2.16-1**). Based on temporary wells installed in 2008 in the upgradient portion of the plume and data for upgradient monitoring wells, there doesn't appear to be a continuing source of contamination present.

3. *Is the system operating as planned? Specifically, is the aquifer being restored as planned identified in the Explanation of Significant Differences to the OU III Record of Decision?*
The system was designed to meet the ROD and ESD cleanup goal of reaching the MCL by 2040. The original system design was for one extraction well operating for approximately 10 years to actively treat the Sr-90 plume, followed by 30 years of natural attenuation and radioactive decay. Based on increased Sr-90 concentrations identified in monitoring wells further downgradient, two additional extraction wells were installed in 2007 to ensure the cleanup goals would be met. The two additional extraction wells are also expected to operate approximately through 2017.

4. *Have the cleanup goals been met? Can the groundwater treatment system be shut down?*
No. Based on groundwater monitoring data discussed in **Section 3.2.16.3**, significant contamination remains upgradient of extraction wells EW-1, EW-2, and EW-3. If this were left untreated, the cleanup goal of meeting DWS by 2040 would not be met.

3.2.16.7 Recommendations

The following are the recommendations for the Chemical/Animal Holes Strontium-90 Treatment System and groundwater monitoring program:

- Continue to operate extraction wells EW-1, EW-2 and EW-3 in full-time mode.
- Maintain the operations and maintenance phase monitoring well sampling frequency begun in 2009.
- Drop wells 106-24, 106-25 and 114-01 from the monitoring program since there have been no historical detections of Sr-90 in this well.
- Complete temporary well investigations in the vicinity of monitoring well 106-48 to determine the current plume perimeter.

3.2.17 HFBR Tritium Pump and Recharge System

In late 1996, tritium was detected in monitoring wells near the HFBR. The source of the release was traced to the HFBR spent fuel pool. In response, the fuel rods were removed and the spent fuel pool was drained. In May 1997, a three-well groundwater pump and recharge system was constructed on the Princeton Avenue firebreak road approximately 3,700 feet downgradient of the HFBR to capture tritium and assure that the plume would not migrate off site. Extracted water was recharged at the RA V recharge basin. Groundwater modeling projected that the tritium plume would attenuate naturally to below DWS (20,000 pCi/L) before reaching the site boundary. The extraction system was placed on standby status in September 2000, as groundwater monitoring data demonstrated that the plume was attenuating to concentrations well below DWS in the vicinity of the Pump and Recharge extraction wells.

As described in the OU III ROD, the selected remedy to address the HFBR tritium plume included implementing monitoring and low-flow extraction programs to prevent or minimize the plume’s growth. Beginning in June 2000 and ending April 2001, 20 low-flow extraction events removed 95,000 gallons of tritiated water with concentrations greater than 750,000 pCi/L. This water was sent off site for disposal.

The OU III ROD contingencies are defined as either a detection of tritium above 25,000 pCi/L in monitoring wells at the Chilled Water Facility Road, or above 20,000 pCi/L in monitoring wells along Weaver Drive. The OU III ROD contingency of exceeding 20,000 pCi/L at Weaver Drive was triggered with a detection of 21,000 pCi/L in November 2006. In 2007, new extraction well EW-16 was installed to supplement the three existing extraction wells and the system was restarted in November 2007 as per the ROD contingency.

Groundwater flow in the vicinity of the HFBR is primarily to the south (**Figures 2-2** and **2-3**).

3.2.17.1 System Description

As a result of the implementation of the ROD contingency described above, operation of the system resumed in November 2007 and includes the pumping of wells EW-16 and EW-11. Extraction well EW-16 was installed approximately 400 feet north of the existing pump and recharge wells located on Princeton Avenue (**Figure 3.2.17-1**). Extraction wells EW-9, EW-10, and EW-11 are being sampled quarterly and EW-16 is being sampled at a weekly frequency. A pre-start-up sample obtained on November 28, 2007 showed tritium at 6,580 pCi/L. Since that time, the tritium concentrations in EW-16 have ranged from 970 to 3,620 pCi/L.

For a complete description of the HFBR Tritium Pump and Recharge System, see the *Operations and Maintenance Manual for the High Flux Beam Reactor Tritium Plume Pump and Recharge System* (BNL 2009c).

3.2.17.2 Groundwater Monitoring

Well Network

A monitoring well network of 103 wells is used to evaluate the extent of the plume, monitor the source area, and verify the predicted attenuation of the plume (**Figure 1-2**). The permanent monitoring well network is supplemented with temporary wells. A total of 17 temporary wells were installed and sampled from October 2009 to April 2010. (**Figure 3.2.17-1** and **Table 3.2.17-1)**. There was only one round of temporary well sampling in 2009 due to the construction of the National Synchrotron Light Source II facility impacting access to a number of locations. The loss of these wells should have no impact on the effectiveness of the groundwater monitoring program, as these areas are supplemented with temporary wells as needed.

Sampling Frequency and Analysis

Sampling details for the well network are provided on **Table 1-5**. Select wells are also analyzed for VOCs as part of the Carbon Tetrachloride and Middle Road programs.

3.2.17.3 Monitoring Well Results

The extent of the tritium plume is shown on **Figure 3.2.17-1**. This figure summarizes data collected from monitoring wells during the fourth quarter of 2009, supplemented with data obtained from 17 temporary wells installed from October 2009 through April 2010 **(Table 3.2.17-1)**. The temporary wells were installed to fill in data gaps along key segments of the plume. Specifically, the temporary wells were installed between Temple Place and Brookhaven Avenue, and then in several locations between EW-16 and the area south of Rowland Street where the high concentration segment of the plume is currently located (**Figure 3.2.17-1**). **Appendix C** contains the complete set of monitoring well data. A north–south cross-sectional view of the plume centerline is shown on **Figure 3.2.17-2**. Tritium concentration trends for key monitoring wells are shown on **Figure 3.2.17-3**.

Background

Samples are collected from a network of seven monitoring wells north of the HFBR. These wells serve as early detection points if groundwater flow shifts to a more northerly direction and toward supply wells 10, 11, and 12. Groundwater flow during 2009 was consistently to the south. Supply well 10 and 11 provided less than 25% of the lab’s water supply in 2009 and did not have a significant impact on sitewide groundwater flow directions. The g-2 plume is present in the vicinity of the HFBR, approximately 10 to 20 feet deeper than the HFBR plume. A characterization of the downgradient extent of the g-2 tritium plume was conducted again in 2009 and is summarized in **Section 4.2**.

HFBR to Brookhaven Avenue

Tritium concentrations directly downgradient from the HFBR have been observed to correlate with peak water-table elevations in response to water-table flushing of the unsaturated zone beneath the HFBR. There was a steady decline in water-table elevations from the middle of 2007 through 2008, which minimized water-table flushing beneath the HFBR during that time, and is at least partially contributing to the declining tritium trends over the same period. There was a steady increase in water-table elevation through 2009 with no resulting spike in source area monitoring well tritium concentrations to date. It is important to note that there was a sharp rise in water-table elevation at the site during the first quarter of 2010 due to well above average precipitation during the winter months. The water table was nearing historical high elevations as of May 2010. It would be expected that any remaining inventory of tritium in the unsaturated zone beneath the HFBR spent fuel pool may be mobilized by this water table increase. The HFBR source area wells will continue to be monitored in 2010 for this possibility. Based on the long-term trend, it is anticipated that peak tritium concentrations in these wells will be less than the 20,000 pCi/L DWS within the next several years.

The peak 2009 tritium concentration in this area was 17,900 pCi/L in well 075-44 (located on the HFBR south lawn) in March 2009 (**Figure 3.2.17-4**). The tritium concentrations in this well declined to 2,110 pCi/L by October of 2009. It appears based on some increases in concentrations in several of the westernmost monitoring wells in this area that the plume may have shifted slightly to the west during 2009. There were no concentrations above the DWS of 20,000 pCi/L in any of the wells in this area during 2009. The monitoring well network was supplemented with four temporary wells in 2009 to better characterize the eastern edge of the plume from Temple Place to Brookhaven Avenue. The HFBR tritium plume as depicted on **Figure 3.2.17-1** now consists of several discontinuous segments. In the fourth quarter of 2009 there were no tritium concentrations above the DWS from the HFBR to Brookhaven Avenue although a small area of inferred concentrations above 20,000 pCi/L is shown approximately 200 feet south of Temple Place based on 2008 data and tritium transport rates.

Brookhaven Avenue to Princeton Avenue Firebreak Road

The monitoring well network in this area was supplemented with 13 temporary wells during 2009/2010. The plume in this area has become discontinuous as defined by the 20,000 pCi/L contour.

The discontinuous nature of the plume is the result of the intermittent nature of tritium flushing in the vadose zone beneath the HFBR over the past several years resulting in pulses or slugs of tritium.

The high concentration downgradient slug is now located between the Weaver Drive area and pump and recharge well EW-16. Temporary wells installed along the Chilled Water Facility transect in 2008 and 2009 have shown peak tritium concentrations below 20,000 pCi/L following a detection of 113,000 pCi/L in this area in 2007. The highest tritium concentration observed in the plume was 56,600 pCi/L in GP-340, located about 100 feet north of EW-16.

EW-16 is sampled on a weekly basis. The peak concentration in this well was 3,620 pCi/L during June of 2009. Tritium concentrations slowly dropped off thereafter, and have remained below 2,400 pCi/L since August of 2009. Tritium has not been detected in perimeter monitoring well 096-118, located approximately 200 feet east of EW-16, which confirms that the plume is within the capture zone of the extraction well. **Table F-48** presents the VOC and tritium detections in the extraction wells for 2009.

3.2.17.4 System Operations

Extraction wells EW-9, EW-10, and EW-11 were sampled quarterly, whereas EW-16 was sampled quarterly for VOCs and weekly for tritium in 2009. The influent, midpoint, and effluent of the carbon units were sampled twice per month, along with weekly pH readings. These samples were analyzed for VOCs and tritium. Extraction wells EW-11 and EW-16 are in full-time operation, while EW-9 and EW-10 are in standby mode. **Table 3.2.17-2** shows the 2009 SPDES equivalency permit levels.
The following is a summary of the OU III HFBR AOC 29 Tritium System operations for 2009:

January – September 2009

The system was off for the month of January due to the electrical construction work conducted at the NSLS II project. Otherwise, normal down time was experienced due to scheduled maintenance and alarm testing. During the first three quarters of 2009 approximately 75 million gallons of groundwater were pumped and recharged.

October – December 2009

The system operated normally during the last quarter of 2009. Approximately 29 million gallons of groundwater were pumped and recharged.

Extraction Well Operational Data

During 2009, approximately 103 million gallons of groundwater were pumped and recharged by the OU III HFBR AOC 29 Tritium System, with an average flow rate of 193 gpm. **Table 3.2.17-3** shows the monthly extraction well pumping rates whereas **Table F-48** shows VOC and tritium concentrations.

3.2.17.5 System Evaluation

The OU III HFBR Tritium Pump and Recharge System and Monitoring Program can be evaluated based on five major decision rules established for this program using the groundwater DQO process.

Table 3.2.17-2
OU III HFBR AOC 29 Tritium System
2009 SPDES Equivalency Permit Levels

Parameters	Permit Level (µg/L)	Max. Measured Value (µg/L)
pH	5.5–8.5 SU	5.7-7.7 SU
Carbon tetrachloride	5	ND
Chloroform 7		ND
1,1-Dichloroethane	5	ND
1,2-Dichloroethane 0.6		ND
1,1-Dichloroethene 5		ND
Cis-1,2-Dichloroethylene	5	ND
Trans-1,2-Dichloroethylene 5		ND
Tetrachloroethylene 5		ND
1,1,1-Trichloroethane 5		ND
Trichloroethylene	5	ND

Note:
ND = Not detected above method detection limit of 0.50 µg/L.
SU = Standard Units

1. Was the BNL Groundwater Contingency Plan triggered?
No. There were no unusual or unexpected concentrations of contaminants observed in the monitoring wells or the extraction wells associated with the HFBR Tritium Pump and Recharge System during 2009. The Pump and Recharge system restarted in November 2007 in response to triggering the ROD contingency of 20,000 pCi/L at Weaver Drive in 2006 during continued operation.

2. Is the tritium plume growing?
No. Based on the position of the 20,000 pCi/L isocontour line, the high concentration segment of the plume has migrated to between Weaver Drive and EW-16, which is positioned to capture the plume. The area immediately downgradient of the HFBR was below DWS during 2009. There has been a notable reduction over the past several years in both the frequency and concentrations of new tritium slugs. See **Figure 3.2.17-5** for the plume distribution comparison between 1997 and 2009.

3. Are observed conditions consistent with the attenuation model?
Yes. Groundwater modeling conducted in 2007 to address the downgradient high concentration plume segment approaching Weaver Drive predicted that the pump and recharge system would operate for a duration of approximately 2-4 years. This prediction is reasonable based on the tritium concentrations observed in this area in 2009.

4. Is the tritium plume migrating toward the zone of influence of water supply wells 10 and11?
No. Groundwater flow from this area was to the south during 2009 (**Figure 2-2**).

5. Has any segment of the plume migrated beyond the current monitoring network?
No. The plume is monitored by a combination of permanent wells supplemented with temporary wells, where necessary, to ensure that the plume extent is characterized.

3.2.17.6 Recommendations

The following are recommendations for the HFBR AOC 29 Tritium Pump and Recharge System and monitoring program:

- Increase the sampling frequency for monitoring wells 075-42, 075-43, 075-44, and 075-45 to monthly as a result of the historical high water-table elevations during 2010 to monitor for any corresponding source area tritium releases. Continue monitoring for six months and then re-evaluate based on water-table conditions and observed tritium data.
- Continue to install and sample temporary wells as necessary to characterize the location of the high tritium concentration area approaching EW-16. Results will be communicated to the regulators via the IAG conference call and quarterly/annual reports.
- Continue operating EW-16 and EW-11 in 2010. Monitor tritium concentrations in EW-16 on a weekly basis.
- The pump and recharge well(s) will be operated until the tritium concentrations from Weaver Drive to EW-16 drop below 20,000 pCi/L. The estimated operational duration of 2 to 4 years (2011 to 2013) is based on the length of the high concentration area slug and the time it would take to be completely captured by EW-16. The decision to turn the wells back to standby will be based on:
    - concentrations of tritium decreasing to less than 20,000 pCi/L in the monitoring wells at Weaver Drive as well as the extraction wells, and

- verification that EW-16 has captured concentrations of tritium greater than 20,000 pCi/L in this area. A decision to turn the wells back to standby will be supported with data from additional permanent and temporary wells, as needed.

This page intentionally left blank.

3.3 OPERABLE UNIT IV

This section summarizes the data from the Former OU IV Air Sparging/Soil Vapor Extraction (AS/SVE) System and offers conclusions and recommendations for monitoring.

3.3.1 OU IV AS/SVE System Post Closure Monitoring Program

The OU IV AS/SVE System was shut down in August 2001, and further monitoring was continued as per *OU IV Remediation Area 1 Proposed Supplemental Remedial Effort – Work Plan* (BNL 2001b). The *Petition for Closure and Termination of Formal Post Closure Monitoring of OU IV Air Sparge/Soil Vapor Extraction Remediation System* (BNL 2002c) was submitted to the regulatory agencies in June 2002. BNL received regulatory approval in July 2003 and decommissioned the system in December 2003.

3.3.1.1 Groundwater Monitoring

Well Network

The *Final CERCLA Five Year Review Report for OU IV* (BNL 2003b) stated that monitoring under this program should continue for three monitoring wells: 076-04, 076-06, and 076-185.

Monitoring wells 076-18 and 076-19 continue to be monitored under the BNL Facility Monitoring Program for the Central Steam Facility. The remaining monitoring wells were either included under the radionuclide monitoring under the Building 650 and Sump Outfall Strontium-90 Monitoring Program (**Section 3.3.2**) or abandoned as per the final report (BNL 2003b) **(Figure 1-2).**

Sampling Frequency and Analysis

Monitoring wells 076-04 and 076-06 were sampled and analyzed annually for VOCs and semivolatile organic compounds. Well 076-185 was sampled and analyzed for VOCs semi-annually.

3.3.1.2 Monitoring Well Results

Post-closure sampling of monitoring wells was conducted for 2009. The complete groundwater data are given in **Appendix C**. There were no detections of SVOCs above reporting limits in any of the samples collected. The only VOCs detected above the NYS AWQS were cis-1,2-dichloroethylene and PCE in well 076-185. The compounds cis-1,2-dichloroethylene and PCE were detected above the NYS AWQS in the April and November rounds at concentrations up to 19 µg/L and 23 µg/L, respectively. These results confirm those reported from the third quarter of 2008. This contamination most probably originated from spills at the Central Steam Facility.

3.3.1.3 Post-Closure Monitoring Evaluation

The system can be evaluated based on the decision rule identified during the groundwater DQO process.

1. Was the BNL Contingency Plan triggered?

No. There were no unexpected VOC concentrations in groundwater during 2009.

3.3.1.4 Recommendation

The following is recommended for the OU IV AS/SVE Post Closure Monitoring program:

- Due to the increasing concentrations of cis-1,2-dichloroethylene and tetrachloroethylene, the sampling frequency of monitoring well 076-185 should increase to semi-annual.

This page intentionally left blank.

3.3.2 Building 650 and Sump Outfall Strontium-90 Monitoring Program

The Building 650 and Sump Outfall Strontium-90 Monitoring Program monitors a Sr-90 plume emanating from a remediated source area known as the former Building 650 Sump Outfall Area. This former source consisted of a depression at the terminus of a discharge pipe from the building. The pipe conveyed discharges from a concrete pad located approximately 1,200 feet to the west, where radioactively contaminated clothing and equipment were decontaminated beginning in 1959.

Remediation (by excavation) of the contaminated soils associated with the Building 650 sump outfall and removal of the pipe leading to the outfall, as well as soil, concrete, and asphalt associated with the former decontamination pad behind Building 650, were completed in 2002.

3.3.2.1 Groundwater Monitoring

Well Network

The network consists of 24 wells used to monitor the Sr-90 concentrations originating from the former Building 650 sump outfall area (**Figure 1-2 and 3.3.2-1**).

Sampling Frequency and Analysis

During 2009, the wells were monitored either annually or semiannually, and the samples were analyzed for Sr-90 (**Table 1-5**).

3.3.2.2 Monitoring Well/Temporary Well Results

The complete monitoring well radionuclide sampling results can be found in **Appendix C**. The Sr-90 plume originating from the Building 650 sump outfall continues to migrate slowly southward away from the former sump outfall area. Based on a recommendation from the 2008 Report the monitoring well network was supplemented with 14 temporary wells in order to characterize the leading edge of this plume and the location of the downgradient plume core. The locations of the permanent and temporary wells and the Sr-90 concentrations are shown on **Figure 3.3.2-1**. The temporary well data (obtained using a Geoprobe) is summarized in **Table 3.3.2-1.** The leading edge of the plume as defined by the 8 pCi/L DWS is presently located approximately 400 feet north of Brookhaven Avenue. Sr-90 concentrations in the source area continue to decrease as evidenced by the declining Sr-90 concentrations in wells 076-13 and 076-169 over the prior twelve years (**Figure 3.3.2-2**). During 2009/2010, the highest Sr-90 concentration (74 pCi/L) was detected in temporary well AOC 6-GP-05 in January 2010. Based on the temporary well characterization it appears that the center-line of the plume is located approximately 50 to 100 feet west of well 076-24. The highest concentrations within the plume appear to be between approximately 500 feet to the north of Brookhaven Avenue. The plume appears to be behaving as predicted and a recommendation will be made to update the groundwater model with the latest data and determine the predicted date range in which attenuation of the plume to below drinking water standard can be expected.

3.3.2.3 Groundwater Monitoring Program Evaluation

The monitoring program can be evaluated based on the three decision rules identified from the groundwater DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?

No. There were no unexpected Sr-90 concentrations detected in groundwater during 2009.

2. Were performance objectives met?

No. The performance objective for this project is to achieve Sr-90 concentrations below the DWS of 8 pCi/L. There were three permanent and two temporary wells exceeding this limit in 2009 (076-13, 076-169, 076-24, AOC6-GP-04, and AOC6-GP-05). Therefore, the performance objectives have yet to be achieved. The removal of contaminated soils in 2002 addressed the predominate source of groundwater contamination. The groundwater plume continues to degrade due to natural attenuation (i.e., radioactive decay).

3. If not, are observed conditions consistent with the attenuation model?
Yes. The observed data are consistent with the attenuation model in terms of the extent of Sr-90 contamination.

3.3.2.4 Recommendations

The following recommendations are made for the Building 650 and Sump Outfall Strontium-90 Groundwater Monitoring Program:

- Drop monitoring wells 066-17, 076-167, 076-20, 076-26, and 076-183 from the monitoring program. The sampling frequency is currently annual in these wells. This recommendation is based on both the long history of very low Sr-90 detections in these wells along with the fact that they are clearly outside of the Sr-90 plume area based on the latest comprehensive plume characterization. The sampling of wells can be resumed and sampling frequencies increased if warranted by future changes in groundwater flow conditions.
- Re-instate an annual sampling frequency for well 076-182 in light of the latest plume characterization as it appears to be positioned as a sentinel well for the leading edge of the plume.
- Update the groundwater model with the 2009/2010 characterization data and run a new simulation to predict the expected time frame for achieving drinking water standards by natural attenuation of the plume.
- Install two monitoring wells in the downgradient plume core area and a sentinel well near the leading edge of the plume.

3.4 OPERABLE UNIT V

3.4.1 Sewage Treatment Plant Monitoring Program

The Sewage Treatment Plant (STP) processes sanitary wastewater from BNL's research and support facilities. Treated effluent from the STP is discharged to the Peconic River under a NYSDEC SPDES permit. Historically, BNL's STP received discharges of contaminants from routine operations. Releases of low-level contaminants to groundwater (in particular, VOCs, metals, and radionuclides) occurred via the STP sand filter beds and discharges to the Peconic River. The OU V project monitors the identified groundwater contamination downgradient of the STP. Groundwater quality in the immediate vicinity of the STP is being monitored under the Facility Monitoring Program, which is discussed in **Section 4.6** of this document.

3.4.2 Groundwater Monitoring

Well Locations

A network of 34 monitoring wells was designed to track groundwater contamination downgradient of the STP, at the site boundary, and off site (**Figure 1-2**).

Sampling Frequency and Analysis

All 34 wells are sampled annually for VOCs and tritium, and eight wells are sampled annually for perchlorate (**Table 1-5)**.

3.4.3 Monitoring Well Results

The OU V wells were sampled once during 2009. **Appendix C** contains the complete data. The VOC plume extends from south and east of the STP to the vicinity of the Long Island Expressway (LIE) (**Figure 3.4-1**). During 2009, the highest TVOC concentration was 6 µg/L in off-site plume core well 000-122 located immediately north of the LIE. The highest individual VOC in this well was TCE at a concentration of 3 µg/L. The AWQS for TCE is 5 µg/L. VOC concentrations in on-site plume core wells continued to decline. The TVOC concentrations in off-site plume core well 000-122 have shown a decreasing trend since early 2005 (**Figure 3.4-2)**. It appears that this plume has reached an equilibrium state in the aquifer with the leading edge attenuating in the vicinity of 000-122 (based on the downgradient well data). There were no individual VOCs detected at levels exceeding NYS AWQS. There have been no significant changes to the VOC plume over the past several years, other than the continued, gradual decline in concentrations (**Figure 3.4-2**). A comparison of the plume from 1997 to 2009 is shown on **Figure 3.4-3**.

In August 2004, the 34 OU V monitoring wells were sampled and analyzed for perchlorate in response to a request from the SCDHS. The sampling program has been gradually been reduced over the past five years in response to a decrease in perchlorate detections and concentrations. Perchlorate was detected in two of the 2009 samples (wells 050-01 and 061-05) at concentrations just above detectable limits. The NYSDOH Action Level for perchlorate in drinking water supply wells is 18 µg/L. The EPA published a Drinking Water Equivalent Level for perchlorate of 24.5 µg/L in January 2006. Monitoring will continue for these eight wells in 2010.

Tritium has historically been detected at low concentrations in monitoring wells 049-06, 050-02, and 061-05. Tritium concentrations in each of these wells have steadily declined over the past 12 years. During 2009, the maximum tritium concentration detected was 940 pCi/L in well 061-05; this is approximately one-twentieth the NYS AWQS of 20,000 pCi/L. Tritium was not detected in the off-site monitoring wells.

3.4.4 Groundwater Monitoring Program Evaluation

The OU V Groundwater Monitoring Program can be evaluated in the context of three basic decisions established for this program using the groundwater DQO process:

1. Was the BNL Groundwater Contingency Plan triggered?
No. There were no unexpected contaminant concentrations in groundwater from the OU V Monitoring Program during 2009.

2. Were the performance objectives met?
Yes. The performance objective for this program is to attain NYS AWQS for VOCs in groundwater in the Upper Glacial aquifer within 30 years through monitored natural attenuation. Individual VOCs were below NYS AWQS in the program monitoring wells in 2008 and 2009.

3. Is the extent of the plume still defined by the existing monitoring well network?
Yes. The leading edge of the TVOC plume is in the vicinity of well 000-122 (south of the Long Island Expressway). Currently, two well clusters serve as sentinel wells for this plume along South Street and Wading River Road.

3.4.5 Recommendations

The following recommendations are made for the OU V plume groundwater monitoring program:

- It appears that the OU V VOC plume has largely attenuated. No individual VOC exceeded the NYS AWQS in 2008 or 2009. It was recommended in the 2008 Groundwater Status Report that the monitoring well network be sampled on an annual basis for one more year. If individual VOC concentrations and tritium remained below NYS AWQS during 2009, BNL could recommend reducing the number of wells being monitored. It is recommended that monitoring for VOCs and tritium be discontinued based on the observation that there have been no detections of either constituent above NYS AWQS dating back to 1997 and 1998 (the timeframe in which these wells were installed) in the following wells: 037-02, 037-04, 041-01, 041-02, 041-03, 049-05, 050-02, 061-03, 061-04, 000-123, 000-147, 000-141, 000-142, 000-143, 000-144, 000-145, 000-146, 600-15, 600-16, and 600-18.
- There have been no detections of percholorate in wells 000-122, 000-123, and 049-06 since sampling began in 2004. Based on the absence of perchlorate in these wells over the previous six years analysis for perchlorate will be discontinued. Continue perchlorate sampling in the five remaining monitoring wells for one more year. If perchlorate concentrations are below standards for two consecutive years, sampling for perchlorate will be discontinued.
- If individual VOCs remain below NYS AWQS in monitoring wells during 2010 a petition will be prepared and submitted to the regulatory agencies to conclude the monitoring program.

3.5 OPERABLE UNIT VI EDB PUMP AND TREAT SYSTEM

The OU VI EDB Program monitors the extent of an ethylene dibromide (EDB) plume in groundwater extending from just south of the Long Island Expressway for approximately 4,000 feet. EDB was used during the 1970s as a fumigant for the BNL Biology Department's biology fields located in the southeastern portion of the site (**Figure 3.5-1**). In 1995 and 1996, low levels of EDB were detected in groundwater near the fields. Higher levels were found migrating toward the southern site boundary and off site to the south. In addition, the depth of the plume increased within the Upper Glacial aquifer to the south. During 2009, EDB was not detected on BNL property.

3.5.1 System Description

A groundwater remediation system to address the off-site EDB plume began routine operations in August 2004. The OU VI EDB Treatment System consists of two extraction wells and two recharge wells. A complete description of the system is included in the *Operations and Maintenance Manual for the OU VI EDB Groundwater Treatment System* (BNL 2004e).

3.5.2 Groundwater Monitoring

Well Locations

A network of 24 wells monitor the EDB plume from just north of the BNL south boundary to locations on private property south of North Street (**Figure 3.5-1**). As suggested by EPA during review of the 2008 Groundwater Status Report, an additional perimeter monitoring well in the northeast portion of the plume will be installed in 2010.

Sampling Frequency and Analysis

The OU VI EDB plume monitoring program is in the O&M phase (**Table 1-8**). The sampling frequency for most of the plume core and perimeter wells (**Table 1-5**) is semiannual. The exception to this was core well 000-178 and bypass detection wells 000-508 and 000-519, which remained at a quarterly sampling frequency for the year. The wells are analyzed for EDB according to EPA Method 504. Samples are also analyzed annually for VOCs using EPA Method 524.2. Several wells are incorporated into the OU III South Boundary Radionuclide monitoring program and analyzed for tritium annually. The inclusion of these wells allows for radionuclide monitoring across the entire downgradient site boundary (**Table 1-5**).

3.5.3 Monitoring Well Results

Appendix C contains the complete analytical results of the OU VI EDB monitoring well sampling program. The distribution of the EDB plume is shown on **Figure 3.5-1** for the fourth quarter of 2009. The leading edge of the plume is being captured by extraction wells EW-1E and EW-2E. The plume is located in the deep Upper Glacial aquifer and is generally moving horizontally, as depicted on cross section M–M' (**Figure 3.5-2)**. A summary of key monitoring well data for 2009 follows:

- During 2009, the highest EDB concentration observed in the plume was 1.4 μg/L in core well 000-178. In comparison, during 2008 the maximum concentration in the plume was 1.5 μg/L in well 000-283. As seen in trend **Figure 3.5-3**, the EDB concentrations in wells 000-283 and 000-284 have been declining over the past several years. However, EDB in well 000-178 has been increasing since late 2006, indicating movement of the plume south. This well is upgradient of EW-2E. The federal DWS for EDB is 0.05 μg/L.
- The trailing edge of the EDB plume is moving south, as evidenced by the reduction in concentrations over the past several years in upgradient plume core wells 000-110, 000-175, and 000-209.

- Plume perimeter well 000-500, installed in 2004 in the eastern portion of the plume, has shown increased EDB levels to above the DWS since 2007. The maximum EDB detection in 2009 was 0.43 µg/L. This portion of the plume is downgradient of well 000-178 and will be captured by EW-2E (**Figure 3.0-1**).
- Core well 000-507 has detected gradually increasing levels of EDB above the DWS since it was installed in 2005 through mid 2008. During 2009, EDB concentrations have remained steady, just above the DWS. This well is immediately upgradient of the extraction wells.
- Plume bypass wells 000-501 and 000-508 have not detected EDB in 2009. Since it was installed in March 2009, plume bypass well 000-519 has not detected EDB.

As noted above, the southward migration of the plume can be observed by analyzing the trends on **Figure 3.5-3**. Over the past three years, the EDB concentration has increased in well 000-178, indicating that the core of the plume is located between the extraction wells and wells 000-283 and 000-284. Comparing the plume's distribution from 1999 to 2009 (**Figure 3.5-4**), as well as the EDB concentrations in monitoring wells just south of North Street**,** helps to illustrate the southward movement of the plume. Overall, peak EDB concentrations declined from 7.6 µg/L in 2001 (in well 000-283) to 1.4 µg/L in 2009 (in well 000-178).

EDB was the only VOC detected above the MCL in any OU VI well in 2009 (**Appendix C**).

3.5.4 System Operational Data

The extraction wells are currently sampled monthly. In conformance with the SPDES equivalency permit, the sampling frequency for the influent and effluent is also monthly. All OU VI system samples were analyzed for VOCs and EDB, and the effluent sample was analyzed weekly for pH. **Table 3.5-1** provides the effluent limitations for meeting the requirements of the SPDES equivalency permit. Following a request from DOE, in December 2009 the NYSDEC renewed the EDB groundwater treatment system SPDES equivalency permit for another five years and modified the effluent limits. The effluent criterion for EDB was reduced from 5.0 µg/L to 0.03 µg/L to reflect an updated practical quantitation limit based on EPA Method 504. In addition, effluent criteria were added for methyl chloride and methylene chloride.

Table 3.5-1
OU VI EDB Pump & Treat System
2009 SPDES Equivalency Permit Levels

Parameters	Permit Limit	Max. Measured Value
pH (range)	5.0 – 8.5 SU	5.8 – 7.6 SU
ethylene dibromide	0.03 µg/L	<0.02 µg/L
chloroform	7.0 µg/L	1.3 µg/L
1,1-dichloroethene	5.0 µg/L	<0.50 µg/L
1,1,1-trichloroethane	5.0 µg/L	<0.50 µg/L
methyl chloride	5.0 µg/L	<0.50 µg/L
methylene chloride	5.0 µg/L	<0.50 µg/L

Notes:

Required sampling frequency is monthly for VOCs and weekly for pH.

SU = Standard Units

January – September 2009

The system operated with EW-1E and EW-2E running at 180 and 160 gpm, respectively, for almost this entire period. EW-2E was down from mid- February to mid-March due to a broken flow meter. From January through September, approximately 130 million gallons of water were pumped and treated.

October – December 2009

The system was off for a few weeks in November for development of the injection wells. The system operated normally for the remainder of this period. Approximately 34 million gallons of water were pumped and treated this quarter.

Extraction Wells

During 2009, 164 million gallons were pumped and treated by the OU VI EDB System, with an average flow rate of approximately 320 gpm. **Table 2-3** contains the monthly pumping data for the two extraction wells, and **Table 3.5-2** shows the pumping rates. VOC concentrations for EW-1E (000-503) and EW-2E (000-504) are provided on **Table F-49**. Low levels of EDB were detected monthly in extraction well EW-1E during 2009, with a maximum of 0.075µg/L in March. Ten of the detections of EDB in EW-1E were slightly above the federal DWS of 0.05 µg/L. There were five EDB detections in EW-2E in 2009, with a maximum concentration of 0.03 µg/L. No other VOCs were detected in the extraction wells above the MCLs.

System Influent and Effluent

During 2009, OU VI EDB system discharge parameters were below the regulatory limit specified in the SPDES equivalency permit. Influent and effluent results are reported on **Tables F-50** and **F-51**, respectively. EDB was detected in 10 of 12 monthly sampling events of the influent throughout 2009, with a maximum concentration of 0.076 µg/L. Only two of the 10 detections were above the standard.

Cumulative Mass Removal

No cumulative mass calculations were performed, based on the typically low detections of EDB historically below the federal DWS in the system influent. The two detections in 2009 were the only historical samples above the standard, except for one detection in early 2005. Several low-level VOCs not attributable to BNL were detected; the results are potentially due to analytical lab contamination and were all below the DWS.

3.5.5 System Evaluation

The OU VI EDB System was designed to capture and remediate the EDB plume as it travels south of BNL with the regional groundwater flow. Start-up of the system was initiated in August 2004, and it is planned to run for approximately 10 years until 2015. The system is operating as designed; no operating difficulties were experienced beyond normal maintenance, and no permit equivalencies have been exceeded.

The OU VI EDB System performance can be evaluated based on the four major decisions identified in the groundwater DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?

No. There were no unusual or unexpected concentrations of contaminants observed in monitoring wells associated with the OU VI EDB plume treatment system.

2. If not, has the plume been controlled?

Yes. An analysis of data from the plume perimeter and bypass wells shows no detections of EDB above the DWS in 2009 except in perimeter well 000-500, located just upgradient and slightly east of extraction well EW-2E. This well had two detections of EDB in 2009, with a maximum of 0.43 µg/L. Extraction well EW-2E is expected to capture this portion of the plume. Based on the recommendation in the *2008 BNL Groundwater Status Report*, an additional well to the northeast of well 000-500 will be installed in 2010 to enhance the monitoring well network. This well will be located next to the treatment system building.

3. Is the system operating as planned? Specifically, is the aquifer being restored as planned?

The hydraulic capture of the system is operating as designed. Since 2007, EDB was detected in the system influent monthly, except for the first two months of 2009. The majority of these detections were at concentrations just below the federal DWS. The plume is migrating towards the extraction wells as projected.

4. Can the groundwater treatment system be shut down?

No, the system has not met all shutdown requirements.

4a. Have asymptotic EDB concentrations been reached in plume core wells?
No. Asymptotic conditions have not yet been achieved.

4b. Are there individual plume core wells above 0.05 μg/L EDB?
In the fourth quarter of 2009, all eight plume core wells had concentrations greater than the 0.05 μg/L federal DWS.

4c. During pulsed operation of the system, is there significant concentration rebound in core wells?
To date, the OU VI EDB system has not been pulsed.

4d. Have the groundwater cleanup goals been met? Are MCLs expected to be achieved by 2030?
No. The federal DWS has not been achieved for EDB in plume core wells. It is expected to be achieved by 2030, as required by the OU VI ROD.

3.5.6 Recommendations

The following recommendations are made for the OU VI EDB Pump and Treat System and groundwater monitoring program:

- Maintain routine operations of the treatment system.
- Change the sampling frequency of the extraction wells from monthly to quarterly.

3.6 SITE BACKGROUND MONITORING

Background water quality has been monitored since 1990. Historically, low levels of VOCs were routinely detected in several background wells that are screened in the deeper portions of the Upper Glacial aquifer.

3.6.1 Groundwater Monitoring

Well Network

The 2009 program included 10 wells in the northwestern portion of the BNL property (**Figure 1-2**). Background quality is defined as the quality of groundwater that is completely unaffected by BNL operations.

Sampling Frequency and Analysis

The samples were collected annually and analyzed for VOCs (**Table 1-5**).

3.6.2 Monitoring Well Results

The complete groundwater analytical data for 2009 are provided in **Appendix C**. There were detections of low levels of several VOCs in the site background wells, all of which were below NYS AWQS. The highest concentration detected was 0.85 µg/L of methyl tertiary-butyl ether in well 018-04.

While radionuclides are no longer analyzed in background wells, historic results are presented for reference purposes. **Table 3.6-1** summarizes the range of radionuclide values detected in background wells from 1996 through 2001.

3.6.3 Groundwater Monitoring Program Evaluation

The program can be evaluated using the decision rule developed as part of the groundwater DQO process.

1. Is groundwater quality at BNL being impacted by off-site, upgradient source(s) of contamination?

No. There were no VOCs detected in site background wells above NYS AWQS during 2009. Based on these results, there is no current impact to BNL groundwater quality from upgradient contaminant sources.

3.6.4 Recommendation

No changes to the monitoring program are warranted at this time.

Table 3.6-1.
Radiological Background Monitoring, 1996 – 2001

Parameter	Activity Range (pCi/L)	Contract-Required Detection Limit
Cesium-137 <MDA	to 7.24	12
Gross alpha	<MDA to 2.66	1.5
Gross beta	<MDA to 6.41	4.0
Strontium-90 <MDA	to 3.84	0.8
Tritium <MDA		300

Note:
<MDA = Less than minimum detectable activity

This page intentionally left blank.

3.7 CURRENT AND FORMER LANDFILL GROUNDWATER MONITORING

Groundwater monitoring data from both the Current and Former Landfills are discussed in detail in the *BNL 2009 Environmental Monitoring Report, Current and Former Landfill Areas* (BNL 2010a). The complete groundwater monitoring results for these programs are included in **Appendix C**.

3.7.1 Current Landfill Summary

Data show that, in general, contaminant concentrations have been decreasing following the capping of the landfill in 1995. By the end of 2009, the landfill had been capped for 14 years. Groundwater quality has been slowly improving. The trend in the data suggests that the cap is effective in mitigating contamination. Groundwater monitoring wells for the Current Landfill are shown on **Figure 3.7-1**. The following is a summary of the results from the samples collected during 2009:

- VOCs such as benzene, and/or chloroethane continue to be detected in downgradient wells 087-11, 087-23, and 088-109 at concentrations above groundwater standards. The maximum chloroethane concentration was 26.9 µg/L in well 088-109. Benzene was detected at a maximum of 2 µg/L in well 088-11. During 2009, TVOC concentrations in these three wells ranged up to 28.7 µg/L indicating that low level VOCs continue to emanate from the landfill. However, an analysis of the trends of VOCs indicated the concentrations are stable to decreasing.

- Landfill water chemistry parameters and metals evaluated during the year suggest that leachate continues to emanate from the landfill, but at low levels.
- Tritium and Sr-90 continue to be detected in the wells downgradient of the Current Landfill, but at concentrations well below groundwater standards. These concentrations were consistent with historical observations.
- Since 1998, there have been no detections of VOCs, water chemistry parameters or radionuclides exceeding groundwater standards in wells 087-24, 088-22, and 088-23. These wells are all screened in the mid-to deep-Upper Glacial aquifer to monitor the vertical extent of contamination from the Current Landfill.
- Although low levels of contaminants continue to be detected, the landfill controls are effective as evidenced by the improving quality of groundwater downgradient of the landfill.

3.7.2 Current Landfill Recommendations

No changes to the Current Landfill groundwater monitoring program are warranted at this time.

3.7.3 Former Landfill Summary

Data show that contaminant concentrations have been decreasing following the capping of the landfill in 1996. Contaminant concentrations downgradient of this landfill were relatively low prior to capping, primarily due to it being approximately 50 years old. The trend in the data suggests that the cap is effective in mitigating any remaining contamination from entering the groundwater. Based on VOC and Sr-90 concentration trends in downgradient wells, it appears that the landfill cap is performing as planned. Groundwater monitoring wells for the Former Landfill are shown on **Figure 3.7-2**. The following is a summary of the results from the samples collected during 2009:

- The Former Landfill Area is not a significant source of VOC contamination. No VOCs were detected above groundwater standards in 2009. VOC concentrations in the downgradient wells were at or near the minimum detectable limits.
- Landfill-leachate indicators in downgradient wells were detected at concentrations approximating those in the background monitoring wells, indicating that leachate generation is minimal to nonexistent.
- The Former Landfill Area no longer appears to be a source of Sr-90 contamination. Only trace amounts of Sr-90 were detected near the Former Landfill Area (Well 097-64). The Sr-90 detected in wells 106-43, 106-44, 106-45 and 106-64 has been decreasing with time and is currently not above groundwater standards.
- The implemented landfill controls are effective, as evidenced by the improving quality of groundwater downgradient of the landfill.

3.7.4 Former Landfill Recommendations

No changes to the Former Landfill groundwater monitoring program are warranted at this time.

4.0 FACILITY MONITORING PROGRAM SUMMARY

During 2009, the Facility Monitoring Program at BNL monitored the groundwater quality at 10 research and support facilities. New York State operating permits require groundwater monitoring at two support facilities (the Major Petroleum Facility and the Waste Management Facility); the remaining eight research and support facilities are monitored in accordance with DOE Order 450.1, *Environmental Protection Program*. This Order requires the Laboratory to establish environmental monitoring programs at facilities that can potentially impact environmental quality, and to demonstrate compliance with DOE requirements and the applicable federal, state, and local laws and regulations. BNL uses these data to determine whether current engineered and administrative controls effectively protect groundwater quality and whether additional corrective actions are needed.

During 2009, 108 groundwater monitoring wells were sampled during approximately 200 sampling events. BNL also installed temporary wells to supplement the network of permanent monitoring wells. Information on groundwater quality at each of the monitored research and support facilities is described below. **Table 1-6** summarizes the Facility Monitoring Program by project. Complete analytical results from groundwater samples collected in 2009 are provided in **Appendix D**.

4.1 Alternating Gradient Synchrotron (AGS) Complex

The structures that constitute the AGS Complex include the AGS Ring, Linear Accelerator (Linac), Building 912, AGS Booster Beam Stop, 914 Transfer Tunnel, former g-2 experimental area, former E-20 Catcher, former U-Line Beam Target, and the J-10 Beam Stop. Activated soil has been created near a number of these areas as the result of secondary particles (primarily neutrons) produced at beam targets and beam stops. A number of radionuclides can be produced by the interaction of secondary particles with the soil that surrounds these experimental areas. Once produced in the soils, some of these radionuclides can be leached from the soils by rainwater, and carried to the groundwater. Of the radionuclides formed in the soil, only tritium (half-life = 12.3 years) and sodium-22 (half-life = 2.6 years) are detected in groundwater. Of these two radionuclides, tritium is more easily leached from the activated soils by rainwater and does not bind to soil particles. When tritium enters the water table, it migrates at the same rate as groundwater flow (approximately 0.75 feet per day). Sodium-22 does not leach out of the soil as readily as tritium, and migrates at a slower rate in the aquifer. The drinking water standard (DWS) for tritium is 20,000 pCi/L, and the standard for sodium-22 is 400 pCi/L.

To prevent rainwater from leaching these radionuclides from the soil, impermeable caps have been constructed over many of the activated soil shielding areas. Specifications for evaluating potential impacts to groundwater quality and the need for impermeable caps over beam loss areas are defined in the Standards Based Management System (SBMS) subject area entitled *Accelerator Safety*. BNL uses 55 groundwater monitoring wells to evaluate the impact of current and historical operations at the AGS beam stop and target areas. The locations of permanent monitoring wells are shown on **Figure 4-1**. The wells are routinely monitored for tritium because it is the best early indicator of a possible release (i.e., tritium is more leachable than sodium-22, and it migrates at the same rate as groundwater).

Following the 1999 installation of an improved monitoring well network at the AGS, BNL detected three tritium plumes that originated from activated soil shielding at the g-2 experimental area, the former U-Line beam stop, and the former E-20 Catcher. The subsequent installation of impermeable caps over these soil activation areas has resulted in a reduction of tritium levels to less than the 20,000 pCi/L DWS in the former U-Line beam stop and E-20 Catcher areas. As discussed below, tritium continues to be detected downgradient of the g-2 (VQ-12 magnet) soil activation area at concentrations that exceed 20,000 pCi/L (**Section 4.2**).

4.1.1 AGS Building 912

Building 912 consists of five interconnected structures that have been used to house as many as four experimental beam lines (A, B, C, and D lines). Although these beam lines stopped operations in 2002, the building could be used for new experiments in the future.

Beam loss and the production of secondary particles at the target areas resulted in the activation of the adjacent floor, and probably the soil beneath the floor. The highest levels of soil activation beneath Building 912 are expected at the former C-Line target cave. Stormwater infiltration around the building is controlled by paving and stormwater drainage systems that direct most of the water to recharge basins north of the AGS complex. Therefore, it is believed that the potentially activated soil underlying the beam targets and stops is adequately protected from surface water infiltration.

4.1.1.1 AGS Building 912 Groundwater Monitoring

Well Network

Twenty-three shallow Upper Glacial aquifer wells are positioned upgradient and downgradient of Building 912 (**Figure 4-1**). The two upgradient wells (054-69 and 055-14) are positioned to monitor potential tritium contamination from sources such as the g-2 area and the former U-Line experimental area. The downgradient wells are positioned to monitor significant beam stop and target areas in Building 912. Ten of the downgradient wells are also used to track a section of the g-2 tritium plume that has migrated underneath Building 912 (**Section 4.2**).

Sampling Frequency and Analysis

During 2009, the six Building 912 wells that are used to track the g-2 tritium plume were sampled two times, whereas the remaining wells were sampled annually. The groundwater samples were analyzed for tritium (**Table 1-6**).

4.1.1.2 AGS Building 912 Monitoring Well Results

As in past years, low-level tritium contamination that is traceable to the g-2 source area continues to be detected in the six downgradient monitoring wells. The g-2 tritium plume has been tracked from the source area, beneath a portion of Building 912, to an area south of the HFBR facility (**Figure 4-8**). Tritium from the g-2 plume was detected in six wells downgradient of Building 912 (065-321, 065-322, 065-323, 065-324, 065-122, and 065-123), with a maximum concentration of 50,100 pCi/L found in a sample from well 065-323 in March 2009. As described in **Section 4.2**, remedial actions for the g-2 source area and tritium plume are described in the Record of Decision (ROD) signed in May 2007 (BNL 2007b). The groundwater monitoring data for the remainder of the Building 912 area wells suggest that tritium is not being released in appreciable amounts from activated soil beneath the experimental floor. Although low levels of tritium were detected in two wells located downgradient of the former C Target area of Building 912 (a maximum of 2,840 pCi/L in well 065-124 and 620 pCi/L in well 065-125), with the close proximity of the defined centerline of the g-2 plume, this tritium could have originated from the g-2 source area.

4.1.1.3 AGS Building 912 Groundwater Monitoring Program Evaluation

As noted above, in areas not impacted by the g-2 tritium plume, only low levels of tritium were detected in the Building 912 area groundwater monitoring wells. If this tritium originates from Building 912, these results indicate that the building and associated stormwater management operations are effectively preventing significant rainwater infiltration into the activated soil below the experimental hall.

4.1.1.4 AGS Building 912 Recommendations

The following is recommended for the AGS Building 912 groundwater monitoring program:

- For 2010, the Building 912 wells used to track the g-2 tritium plume will continue to be sampled semiannually, whereas the remainder of the Building 912 monitoring wells will continue to be sampled annually.

4.1.2 AGS Booster Beam Stop

The AGS Booster is a circular accelerator with a circumference of nearly 660 feet. It is connected to the northwest portion of the main AGS Ring and to the Linear Accelerator (Linac). The AGS Booster, which has been in operation since 1994, receives either a proton beam from the Linac or heavy ions from the Tandem Van de Graaff generator. The booster accelerates protons and heavy ions before injecting them into the main AGS ring. In order to dispose of the beam during studies, a beam stop system was originally constructed at the 10 to 11 o'clock portion of the Booster. In 1999, the beam stop was repositioned to the south side (6 o'clock section) of the Booster ring to accommodate the construction of the NASA Space Radiation Laboratory (NSRL) tunnel.

Although internal shielding around the beam stop was designed to keep secondary particle interactions with the soil to very low levels, a landfill-type geomembrane cap was constructed over the original beam stop region to prevent stormwater infiltration into the activated soil. When the beam stop was repositioned to the 6 o'clock region of the Booster, a coated concrete cap was constructed over the new beam stop area.

4.1.2.1 AGS Booster Groundwater Monitoring

Well Network

Two shallow Upper Glacial aquifer monitoring wells (064-51 and 064-52) are used to monitor the Booster beam stop area (**Figure 4-1**).

Sampling Frequency and Analysis

The Booster area wells were scheduled to be sampled one time during 2009, and the samples were to be analyzed for tritium (**Table 1-6**). However, due to restricted access to the Booster area during extended beam line operations and scheduling issues, these wells were not sampled during 2009.

4.1.2.2 AGS Booster Monitoring Well Results

As noted above, the Booster area wells were not monitored during 2009. Although low levels of tritium were detected in the Booster area wells during 2001 and 2002 (up to 1,340 pCi/L in well 064-52), tritium was not detected in the Booster area wells from 2003 through 2008 (**Figure 4-2**).

4.1.2.3 AGS Booster Groundwater Monitoring Program Evaluation

The low levels of tritium detected during 2001 and 2002 near the Booster were related to a short-term uncovering of activated soil shielding near the former booster beam stop area during the construction of the tunnel leading from the Booster to the NSRL facility. This work, which began in September 1999 and was completed by October 1999, allowed rainwater to infiltrate the low-level activated soil shielding.[1] Tritium has not been detected in the Booster area monitoring wells since 2002.

4.1.2.4 AGS Booster Recommendation

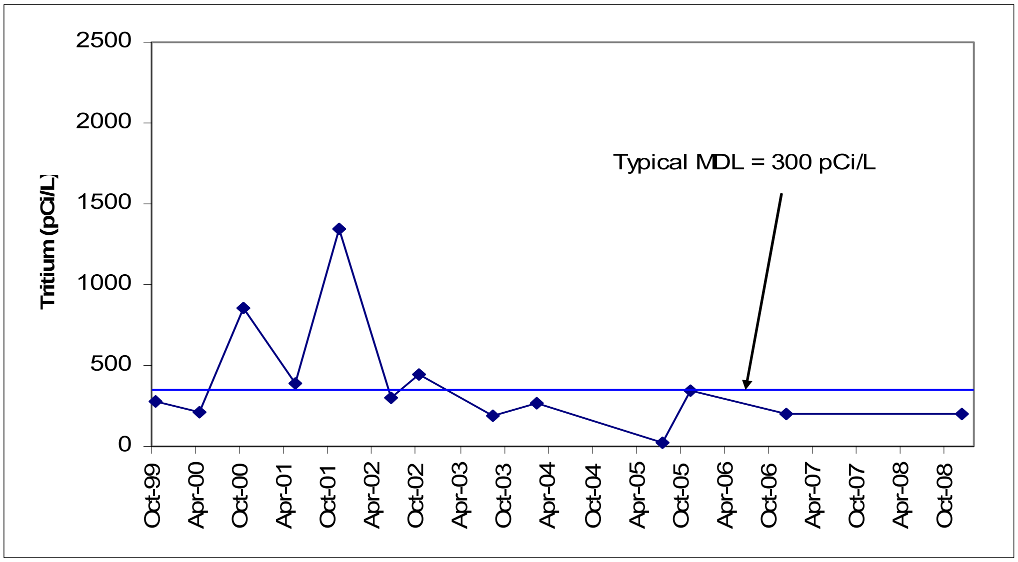
The following is recommended for the AGS Booster groundwater monitoring program:

- For 2010, the monitoring frequency for the Booster area monitoring wells will continue to be annually.

---

[1] Before construction of the NSRL tunnel commenced, soil samples were collected by drilling through the tunnel wall near the former booster beam stop to verify that the tritium and sodium-22 levels were within acceptable limits for worker safety and environmental protection.

Figure 4-2.
AGS Booster Beam Stop
Maximum Tritium Concentrations in Downgradient Wells 064-51 and 064-52



4.1.3 NASA Space Radiation Laboratory (NSRL)

The NSRL is jointly managed by the U.S. Department of Energy’s Office of Science and NASA’s Johnson Space Center. The NSRL employs beams of heavy ions extracted from Brookhaven’s Booster accelerator for radiobiology studies. NSRL became operational during summer 2003. Although the secondary particle interactions with the surrounding soil shielding are expected to result in only a minor level of soil activation, geomembrane caps were constructed over the entire length of the beam line and the beam stop region to prevent stormwater infiltration into potentially activated soil.

4.1.3.1 NSRL Groundwater Monitoring

Well Network

This facility is monitored by two shallow Upper Glacial aquifer monitoring wells (054-08 and 054-191) located immediately downgradient of the NSRL (**Figure 4-1**).

Sampling Frequency and Analysis

The NSRL area wells were monitored one time during 2009, and the samples were analyzed for tritium (**Table 1-6**).

4.1.3.2 NSRL Monitoring Well Results

Groundwater monitoring at the NSRL facility began in late 2002. Since that time, tritium has not been detected in any of the groundwater samples.

4.1.3.3 NSRL Groundwater Monitoring Program Evaluation

Based on monitoring conducted to date, NSRL beam line operations have not impacted groundwater quality.

4.1.3.4 NSRL Recommendation

The following is recommended for the NSRL groundwater monitoring program:

- For 2010, the monitoring frequency for the NSRL wells will continue to be annually.

4.1.4 Former AGS E-20 Catcher

The E-20 Catcher was used from 1984 to 1999, and was located at the 5 o'clock position of the AGS ring (**Figure 4-1**). The E-20 Catcher was a minimum aperture area of the AGS ring, and was used to pick up or "scrape" protons that move out of acceptable pathways.

Like other beam loss areas in the AGS complex, the soil surrounding the former E-20 Catcher became activated by the interaction with secondary particles. In late 1999 and early 2000, tritium and sodium-22 levels in groundwater were found to exceed the DWS, with concentrations of 40,400 pCi/L and 704 pCi/L, respectively. In April 2000, a temporary impermeable cap was installed over the E-20 Catcher soil activation area. A permanent cap was constructed by October 2000. Tritium and sodium-22 concentrations dropped to below their applicable DWS soon after the cap was installed.

4.1.4.1 Former AGS E-20 Catcher Groundwater Monitoring

Well Network

To verify the effectiveness of the impermeable cap over the former E-20 Catcher, the area is monitored by three shallow Upper Glacial aquifer wells (064-55, 064-56, and 064-80). These wells are approximately 100 feet downgradient of the source area (**Figure 4-1**).

Sampling Frequency and Analysis

During 2009, the former E-20 Catcher wells were monitored one time, and the samples were analyzed for tritium (**Table 1-6**). Since 2002, groundwater samples from this area have only been analyzed for tritium.

4.1.4.2 Former AGS E-20 Catcher Monitoring Well Results

Following the installation of the cap in 2000, tritium and sodium-22 concentrations decreased to levels below applicable DWSs (**Figure 4-3**). During 2009, the maximum observed tritium concentration was 890 pCi/L, detected in well 064-80.

4.1.4.3 Former AGS E-20 Catcher Groundwater Monitoring Program Evaluation

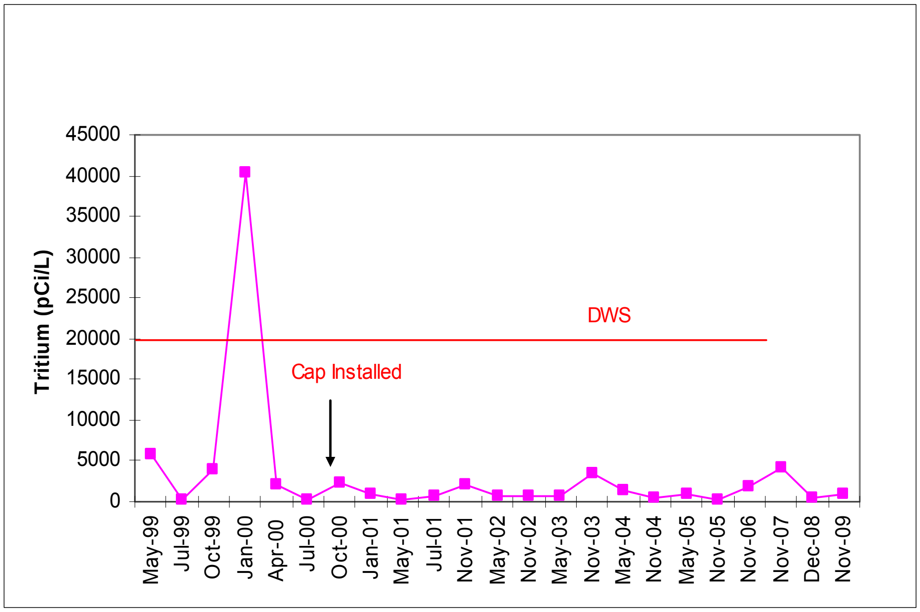
The reduction in tritium concentrations since the impermeable cap was constructed over the former E-20 Catcher area in 2000 indicates that the cap has been effective in preventing rainwater infiltration into the activated soil that surrounds this portion of the AGS tunnel.

4.1.4.4 Former AGS E-20 Catcher Recommendation

The following is recommended for the AGS E-20 Catcher groundwater monitoring program:

- For 2010, the monitoring frequency for the former E-20 Catcher wells will continue to be annually.

Figure 4-3.
Former AGS E-20 Catcher
Maximum Tritium and Sodium-22 Concentrations in Downgradient Temporary and Permanent Monitoring Wells.



4.1.5 AGS Building 914

Building 914 houses the beam transfer line between the AGS Ring and the Booster. Due to beam loss near the extraction (kicker) magnet, the extraction area of Building 914 is heavily shielded with iron. Because the extraction area is housed in a large building, most soil activation is expected to be below the floor of the building, where it is protected from rainwater infiltration.

4.1.5.1 AGS Building 914 Groundwater Monitoring

Well Network

Groundwater quality downgradient of the AGS Building 914 transfer line area is monitored by shallow Upper Glacial aquifer wells 064-03, 064-53, and 064-54 (**Figure 4-1**).

Sampling Frequency and Analysis

During 2009, the AGS Building 914 area wells were monitored one time and samples were analyzed for tritium (**Table 1-6**).

4.1.5.2 AGS Building 914 Monitoring Well Results

Low levels of tritium (up to 1,000 pCi/L) were detected intermittently in groundwater downgradient of the Building 914 during 2000 through 2005 (**Figure 4-4**). Although tritium was not detected in any of the groundwater samples during 2006 and 2007, in 2008 and 2009 low-levels of tritium were detected in well 064-03 at concentrations of 620 pCi/L and 250 pCi/L, respectively.

4.1.5.3 AGS Building 914 Groundwater Monitoring Program Evaluation

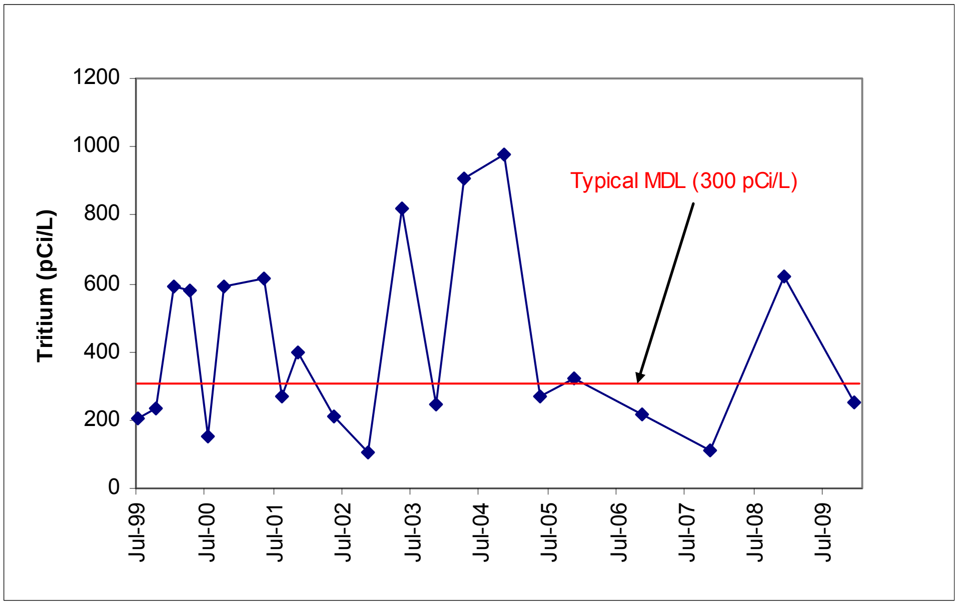
Groundwater monitoring downgradient of AGS Building 914 continues to indicate that the building structure and associated stormwater controls are effectively preventing significant rainwater infiltration into activated soil below the building. However, the periodic detection of trace levels of tritium suggests that some rainwater may be infiltrating the activated soil. Continued monitoring is required.

4.1.5.4 AGS Building 914 Recommendation

The following is recommended for the AGS Building 914 groundwater monitoring program:

- For 2010, the monitoring frequency for the AGS Building 914 area wells will continue to be annually.

Figure 4-4.
AGS Building 914 Transfer Tunnel
Maximum Tritium Concentrations in Downgradient Wells 064-03, 064-53, and 064-54



4.1.6 Former g-2 Beam Stop

The g-2 experiment operated from April 1997 until April 2001. The former g-2 Beam Stop is composed of iron and is covered by soil. Like other beam loss areas in the AGS complex, the former g-2 Beam Stop was an area where the soil surrounding the stop would have become activated by the interaction with secondary particles. To prevent rainwater from infiltrating the soil surrounding the former Beam Stop, BNL installed a gunite cap over the stop area before the start of beam line operations.

In November 1999, tritium and sodium-22 were detected in groundwater monitoring wells approximately 250 feet downgradient of the g-2 experimental area. A groundwater investigation conducted during November and December 1999 revealed a narrow plume of tritium with a maximum tritium concentration of 1,800,000 pCi/L. Sodium-22 was also detected, but at a concentration of only 60 pCi/L, or 15 percent of the 400 pCi/L DWS.

Following the discovery, an investigation into the source of the contamination revealed that the tritium originated from activated soil shielding adjacent to the g-2 experiment's VQ-12 magnet. There was no evidence that any of the tritium originated from the beam stop area. The VQ-12 magnet section of the beam line was not a designed beam loss area, and the gunite cap installed over the nearby beam stop did not protect the VQ-12 area. In December 1999, an impermeable cap was installed over the VQ-12 soil activation area. This cap was joined to the previously installed beam stop cap. In September 2000, the activated soil shielding and associated tritium plume were designated as new sub-Area of Concern 16T. The selected remedial actions for the g-2 tritium source area and plume are documented in a ROD that was signed in May 2007 (BNL 2007b). The monitoring program for the VQ-12 source area and g-2 tritium plume are described in **Section 4.2**.

4.1.6.1 Former g-2 Beam Stop Groundwater Monitoring

Well Network

Groundwater quality downgradient of the former g-2 beam stop is monitored using wells 054-67, 054-68, 054-124, 054-125, and 054-126 (**Figure 4-1**). These wells are cross gradient of the VQ-12 source area monitoring wells described in **Section 4.2**.

Sampling Frequency and Analysis

During 2009, the former g-2 Beam Stop wells were monitored annually, and the samples were analyzed for tritium (**Table 1-6**).

4.1.6.2 Former g-2 Beam Stop Monitoring Well Results

Although trace levels of tritium had been detected during 2008 in three of the four monitoring wells located downgradient of the former g-2 Beam Stop (up to 690 pCi/L in well 054-124), tritium was not detected in any of the wells in 2009.

4.1.6.3 Former g-2 Beam Stop Groundwater Monitoring Program Evaluation

Monitoring of wells downgradient of the former g-2 Beam Stop indicates that the cap is effectively preventing rainwater from infiltrating the activated soil shielding.

4.1.6.4 Former g-2 Beam Stop Recommendation

The following is recommended for the former g-2 Beam Stop groundwater monitoring program:

- During 2010, the former g-2 Beam Stop area wells will continue to be monitored on an annual basis.

4.1.7 AGS J-10 Beam Stop

In 1998, BNL established a new beam stop at the J-10 (12 o'clock) section of the AGS Ring, replacing E-20 as the preferred repository for any beam that might be lost in the AGS Ring (**Figure 4-1**). The J-10 Beam Stop area of the AGS Ring is covered by layers of soil-crete (a sand and concrete mixture), which reduce the ability of rainwater to infiltrate the potentially activated soil. BNL also constructed a gunite cap over a small section of the J-10 region that did not have a soil-crete cover before beam stop operations began.

4.1.7.1 AGS J-10 Beam Stop Groundwater Monitoring

Well Network

The monitoring well network for the J-10 Beam Stop consists of upgradient well 054-62 and downgradient wells 054-63 and 054-64 (**Figure 4-1**).

Sampling Frequency and Analysis

During 2009, the three J-10 Beam Stop wells were monitored one time and the samples were analyzed for tritium (**Table 1-6**).

4.1.7.2 AGS J-10 Beam Stop Monitoring Well Results

Since 2001, low levels of tritium (up to 1,000 pCi/L) have been routinely detected in groundwater downgradient of the J-10 beam stop (**Figure 4-5**). During 2009, trace levels of tritium were detected in both downgradient wells, with a maximum concentration of 490 pCi/L detected in well 054-63.

4.1.7.3 AGS J-10 Beam Stop Monitoring Program Evaluation

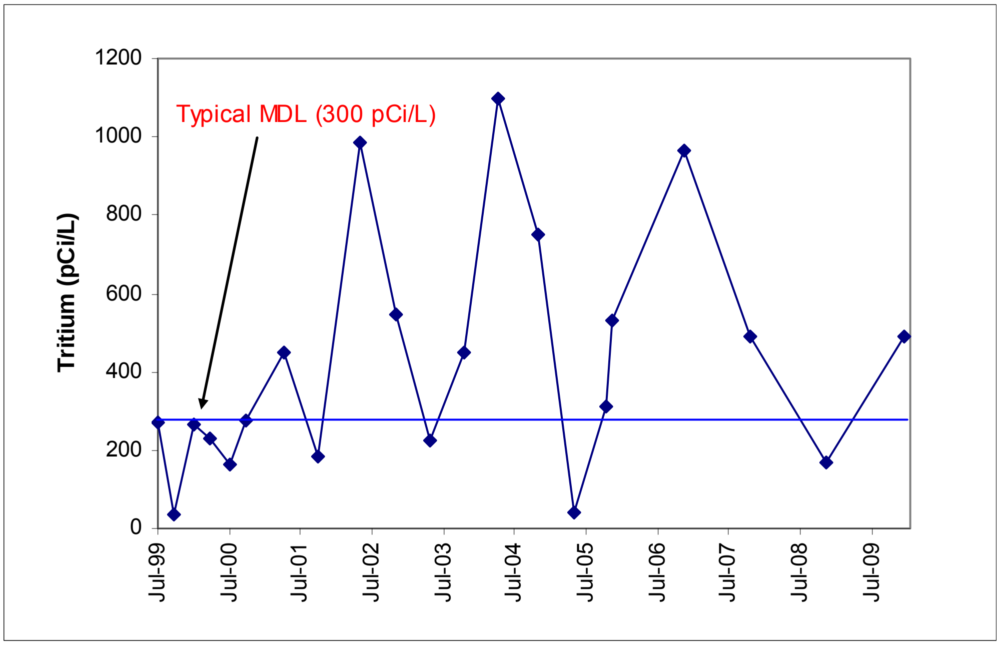
Groundwater monitoring results indicate that the engineered controls in place at J-10 are preventing significant rainwater infiltration into the activated soil shielding. The occasional detection of low levels of tritium (up to 1,000 pCi/L), indicates that the water infiltration is only minor. Continued groundwater monitoring is required to verify the long-term effectiveness of the controls.

4.1.7.4 AGS J-10 Beam Stop Recommendation

The following is recommended for the AGS J-10 Beam Stop groundwater monitoring program:

- During 2010, the J-10 Beam Stop area wells will continue to be sampled on an annual basis.

Figure 4-5.
AGS J-10 Beam Stop
Maximum Tritium Concentrations in Downgradient Wells 054-63 and 054-64



4.1.8 Former AGS U-Line Beam Target and Stop Areas

The U-Line Beam Target area was in operation from 1974 through 1986. During its operation, a proton beam from the AGS would first strike a target and the resulting secondary particles would be selected by an arrangement of magnetic “horns” and collimators immediately downstream of the target. The entire assembly was in a ground-level tunnel covered with an earthen berm. Internal shielding was stacked around the horns. Although the U-Line Beam Target has not been in operation since 1986, the associated tunnel, shielding, and overlying soil remain in place. The former U-Line Beam Target, horns, and Beam Stop are areas where the interaction of secondary particles with soil surrounding the tunnel resulted in production of tritium and sodium-22.

In late 1999, BNL installed monitoring wells downgradient of the target area to evaluate whether residual activated soil shielding was impacting groundwater quality. Subsequent monitoring found low levels of tritium and sodium-22, but at concentrations well below the applicable DWS. In early 2000, BNL installed temporary wells downgradient of the former U-Line Beam Stop, which is approximately 200 feet north of the target area. Tritium was detected at a concentration of 71,600 pCi/L. Sodium-22 was not detected in any of the samples. In May 2000, a temporary impermeable cap was installed over the former U-Line Beam Stop soil activation area to prevent rainwater infiltration and the continued leaching of radionuclides out of the soil and into groundwater. By October 2000, a permanent geotextile cap was constructed.

4.1.8.1 Former AGS U-Line Groundwater Monitoring

Well Network

The former U-Line area is monitored by one upgradient well (054-127), three downgradient wells that monitor the former U-Line Target area (054-66, 054-129, and 054-130), and three wells that monitor the former U-Line Beam Stop area (054-128, 054-168, and 054-169) (**Figure 4-1**).

Sampling Frequency and Analysis

During 2009, the former U-Line area wells were monitored one time, and the samples were analyzed for tritium (**Table 1-6**).

4.1.8.2 Former AGS U-Line Groundwater Monitoring Well Results

Former U-Line Target Area

Although low levels of tritium had been routinely detected in wells downgradient of the former U-line Target from 2000 through 2007, only trace levels of tritium have been detected for the past two years, with a maximum concentration of 400 pCi/L in well 054-129 during 2009 (**Figure 4-6**).

Former U-Line Beam Stop Area

Since the cap was installed over the former U-line Beam Stop in 2000, tritium concentrations in downgradient wells have been well below the 20,000 pCi/L DWS (**Figure 4-7**). During 2009, tritium was not detected in the former U-Line Beam Stop area wells.

4.1.8.3 Former AGS U-Line Groundwater Monitoring Program Evaluation

The significant decrease in tritium concentrations since 2000 indicates that the impermeable cap installed over the former U-Line Beam Stop has been effective in stopping rainwater infiltration into the residual activated soil. Monitoring downgradient of the former U-Line Target indicates that only low levels of tritium are being released.

4.1.8.4 Former AGS U-Line Recommendation

The following is recommended for the former AGS U-Line groundwater monitoring program:

- For 2010, the former U-Line area wells will continue to be monitored for tritium on an annual basis.

Figure 4-6.
Former AGS U-Line Beam Target
Maximum Tritium Concentrations in Downgradient Well 054-129

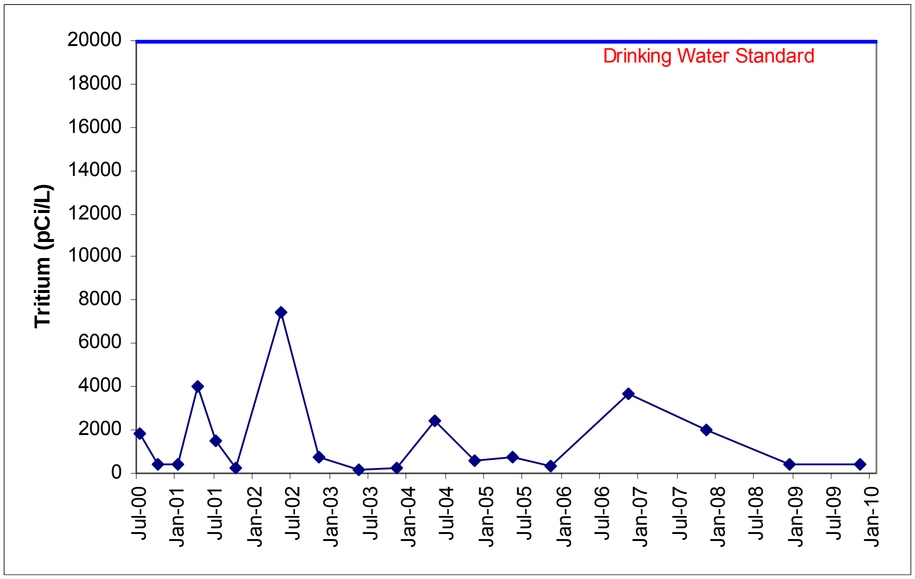
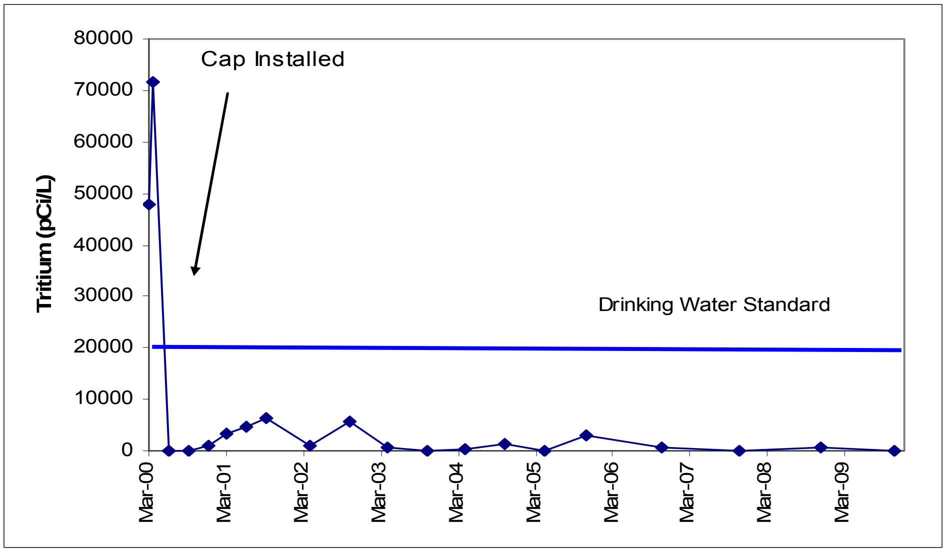


Figure 4-7.
Former AGS U-Line Beam Stop
Maximum Tritium Concentrations in Downgradient Temporary and Permanent Wells



4.2 g-2 Tritium Source Area and Groundwater Plume

In November 1999, tritium was detected in the groundwater near the g-2 experiment at concentrations above the 20,000 pCi/L DWS. Sodium-22 was also detected in the groundwater, but at concentrations well below the 400 pCi/L DWS. An investigation into the source of the contamination revealed that the tritium and sodium-22 originated from activated soil shielding located adjacent to the g-2 target building, where approximately five percent of the beam was inadvertently striking one of the beam line magnets (magnet VQ-12). Rainwater was able to infiltrate the activated soils and carry the tritium and sodium-22 into the groundwater. To prevent additional rainwater infiltration into the activated soil shielding, a concrete cap was constructed over the area in December 1999. Other corrective actions included refocusing the beam and improved beam loss monitoring to reduce additional soil activation, stormwater management improvements, and additional groundwater monitoring.

Following the concurrence from the NYSDEC, a ROD was signed by the DOE and EPA in early 2007 (BNL 2007b). This ROD requires continued routine inspection and maintenance of the impermeable cap, groundwater monitoring of the source area to verify the continued effectiveness of the stormwater controls, and monitoring the tritium plume until it attenuates to less than the 20,000 pCi/L DWS. Monitoring of the source area will continue for as long as the activated soils remain a threat to groundwater quality. Contingency actions have been developed and implemented if tritium levels exceeding 1,000,000 pCi/L are detected within the plume, or if the tritium plume does not attenuate as predicted by the groundwater model.

4.2.1 g-2 Tritium Source Area and Plume Groundwater Monitoring

Well Network

The g-2 tritium plume is currently monitored in two general areas: the source area (including the area to the east of Building 912), and the downgradient segments of the plume currently located south of the HFBR. Monitoring of the source area is accomplished using six wells immediately downgradient of the VQ-12 source (054-07, 054-124, 054-126, 054-184, 054-185, and 064-95) and 12 wells east of Building 912 (065-02, 065-121, 065-122, 065-123, 065-124, 065-173, 065-193, 065-194, 065-321, 065-322, 065-323, and 065-324). Monitoring of the downgradient sections of the tritium plume located south of the HFBR is accomplished using a combination of permanent and temporary wells (**Figures 4-8** and **4-9**).

Sampling Frequency and Analysis

During 2009, the g-2 VQ-12 source area monitoring wells were monitored quarterly, and the samples were analyzed for tritium (**Table 1-6**). One set of quarterly samples was also analyzed for sodium-22. The wells located east of Building 912 were sampled two times during the year. From September 2008 to March 2009, temporary wells were installed along five east-west transects to track the leading edge of the g-2 tritium plume (reported in the 2008 Groundwater Status Report). At nine of these established locations, temporary wells were installed during February through April 2010 along three east-west transects, D, E, and F (**Figure 4-8**). Sample results for the temporary wells are summarized on **Tables 4.2-1** through **4.2-3**.

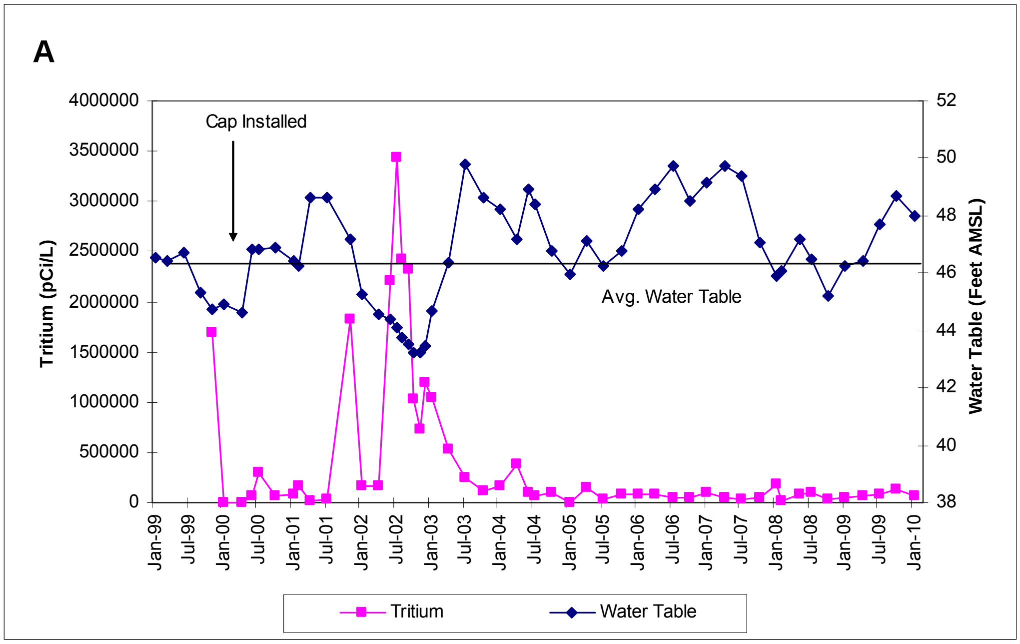
4.2.2 g-2 Tritium Source Area and Plume Monitoring Well Results

Source Area Monitoring Results

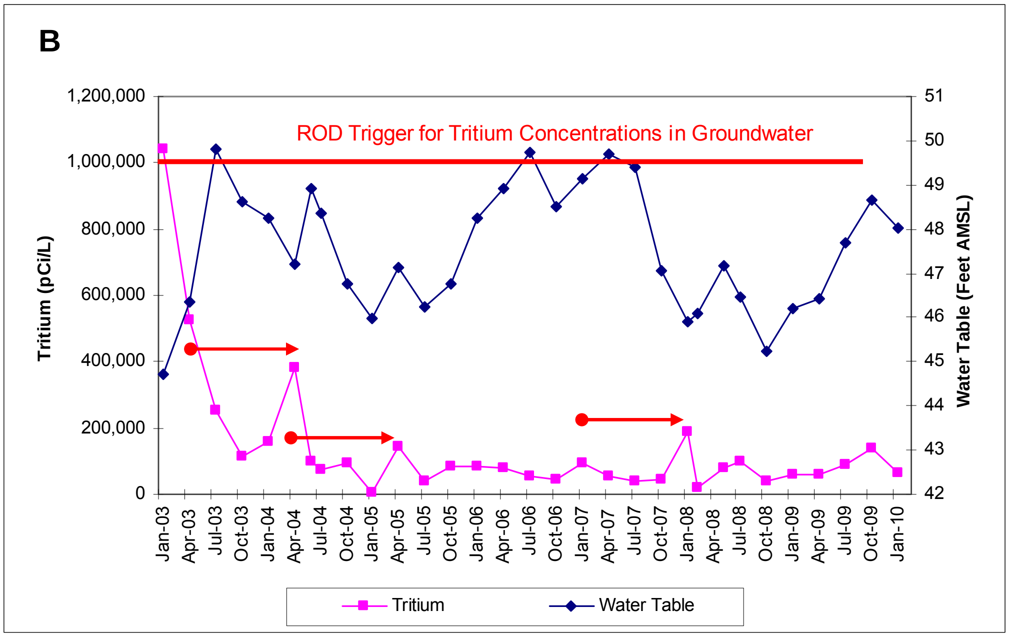
Monitoring data indicate that the high levels of tritium have entered the groundwater as a series of short-term releases (**Figure 4-10**). Following the initial releases of tritium that occurred prior to cap installation in December 1999, subsequent periodic releases, characterized by short-term spikes in tritium concentrations, appear to be related to changes in the water-table elevation. As the water table rises, residual tritium is flushed from the vadose (unsaturated) zone close to the water table. Water levels in the central BNL area in mid-2000, mid-2001, and mid-2003 were near the highest observed in almost 50 years of record for the BNL site, to a level of approximately 49 feet above mean sea level. Approximately one year after each of these periods of high water-table elevations, elevated tritium concentrations were observed in the first set of source area monitoring wells (e.g., tritium concentrations increased to 1.8 million pCi/L in November 2001, and 3.4 million pCi/L in July 2002). Over time, the amount of tritium remaining in the vadose zone near the water table is expected to decrease by this flushing mechanism and by natural radioactive decay. Although the water table increased to nearly 49 feet above mean sea level during three periods since 2003, tritium levels in all but five sets of quarterly samples from source area monitoring wells have been less than 100,000 pCi/L.

During this time period, tritium concentrations reached a maximum 186,000 pCi/L in January 2008 (**Figure 4-10**). During 2009, the maximum tritium concentration was 138,000 pCi/L in the quarterly monitoring samples collected in October. Tritium concentrations dropped to below 63,000 pCi/L by January 2010. The overall reductions in tritium concentrations suggest that the amount of residual tritium that is available to be flushed out of the deep vadose zone is decreasing. Select samples were also analyzed for sodium-22 during all four quarters of 2009. The maximum sodium-22 concentration was 43 pCi/L, detected in the sample from well 054-185. During the first quarter of 2010, the maximum sodium-22 concentration was 40 pCi/L, detected in the sample from well 054-184. The DWS for sodium-22 is 400 pCi/L.

Figure 4-10. g-2 Tritium Source Area
Maximum Tritium Concentrations in Downgradient Wells
A: Maximum tritium concentrations observed from 1999 through January 2010 in groundwater downgradient of the VQ-12 source area. The travel time from the source area to the first set of downgradient monitoring wells is approximately one year.



B: Comparison of January 2003–January 2010 results to the ROD trigger level. Red arrows represent approximately 1 year of travel time from the source area to the first set of downgradient monitoring wells.



Downgradient Areas of the Plume

The extent of the g-2 tritium plume during the first quarter of 2009 is depicted in the 2008 Groundwater Status Report (BNL, 2009), and the extent of the plume during the first quarter of 2010 is depicted on **Figure 4-8**. **Figure 4-9** provides a cross-sectional view of the plume. Monitoring of the downgradient areas of the plume is accomplished using a combination of permanent and temporary wells. As described in **Section 4.1.1.2**, tritium contamination that is traceable to the g-2 source area continues to be detected in monitoring wells located downgradient of AGS Building 912. During 2009, the maximum concentration immediately downgradient of Building 912 was 50,100 pCi/L in a sample from well 065-323 collected in March.

Since June 2007, 41 temporary well locations have been established along six east–west transects (Transects A, B, C, D, E and F). Over this period, temporary wells have been installed at the same locations two to three times to evaluate changes in tritium concentrations over time; with the most recent wells installed between January and April 2010 (**Tables 4.2-1** through **4.2-3**). During the first quarter 2010 sampling events, samples were also collected for Sr-90 to assist in defining the extent of the WCF Sr-90 Plume (**Section 3.2.15**). The downgradient portion of the tritium plume (as defined by concentrations >20,000 pCi/L) is breaking up into discrete segments. Based upon the most recent sampling of the temporary wells, the downgradient portion of the g-2 plume extends from southwest of the HFBR building (Transect D) to an area near the north side of the National Synchrotron Light Source (NSLS) (Transect F), a distance of approximately 600 feet. The highest tritium concentrations were observed along Transects E and F, where 92,200 pCi/L was detected in Transect E temporary well G2-GP-94 (**Table 4.2-2**) and 78,600 pCi/L was detected in Transect F temporary well G2-GP-103 (**Table 4.2-3**). The observed tritium concentrations have been consistent with g-2 Engineering Evaluation/Cost Analysis (EE/CA) model predictions of decay and dispersion effects on the plume segments with distance from the source area.

4.2.3 g-2 Tritium Source Area and Plume Groundwater Monitoring Program Evaluation

Although tritium continues to be detected in the groundwater downgradient of the g-2 source area at concentrations that exceed the 20,000 pCi/L DWS, the reduction in tritium concentrations since 2003 indicates that the cap is effectively preventing rainwater from infiltrating the activated soil shielding. As discussed previously, a comparison of tritium levels in the source area monitoring wells and water-table elevation data suggests that the periodic natural fluctuations in the water table have released residual tritium from the deep vadose zone (i.e., unsaturated soil immediately above the water table). It is believed that this tritium was mobilized to the soil close to the water table before the cap was constructed in December 1999. Once the cap was in place, the lack of additional rainwater infiltration kept the tritium in the vadose zone from migrating into the groundwater until the significant rise in water table mobilized it. There appears to be good correlation between high tritium concentrations detected in monitoring wells immediately downgradient of the source area, and the water-table elevation about one year before the sampling (**Figure 4-10**). Over time, the amount of tritium remaining in the vadose zone near the water table has decrease by this flushing mechanism and by natural radioactive decay. The downgradient portion of the g-2 tritium plume extends from the HFBR area south to the NSLS, and is attenuating in the aquifer as predicted. To fulfill the monitoring requirements defined in the ROD, BNL will continue to monitor groundwater quality in the source area until the activated soils are no longer a threat to groundwater quality, and the downgradient segment of the plume until it has attenuated to concentrations less than the 20,000 pCi/L drinking water standard.

4.2.4 g-2 Tritium Source Area and Plume Recommendations

As required by the ROD, BNL will continue to conduct routine inspections of the g-2 cap, monitor groundwater quality downgradient of the source area, and monitor the downgradient plume segments until tritium levels drop below the 20,000 pCi/L DWS. The following are recommended for the g-2 Tritium Source Area and Plume groundwater monitoring program:

- During 2010, the source area monitoring wells will continue to be sampled quarterly for tritium and annually for sodium-22, and the downgradient sections of the tritium plume will continue to be monitored using a combination of permanent and temporary wells.
- During the spring of 2010, additional temporary wells will be installed along Transect F to verify the western margin of the g-2 tritium plume. During the fall of 2010, additional temporary wells will be installed along Transects D, E, F and new Transect G to track the g-2 plume and evaluate its attenuation in the aquifer.
- Re-run the groundwater model for the downgradient portion of the plume using 2010 monitoring data.

4.3 Brookhaven Linac Isotope Producer (BLIP)

When the Brookhaven Linac Isotope Producer (BLIP) is operating, the Linac delivers a beam of protons that strike a series of targets in the BLIP target vessel, positioned at the bottom of a 30-foot underground tank. The targets rest inside a water-filled, 18-inch-diameter shaft that runs the length of the tank, and are cooled by a 300-gallon, closed-loop primary cooling system. During irradiation, several radionuclides are produced in the cooling water, and soil immediately outside the tank is activated by the production of secondary particles at the target.

As part of a 1985 redesign of the vessel, leak detection devices were installed and the open space between the water-filled shaft and the vessel’s outer wall became a secondary containment system for the primary vessel. The BLIP target vessel system conforms to Suffolk County Article 12 requirements, and is registered with the SCDHS. The BLIP facility also has a 500-gallon UST for storing liquid radioactive waste (change-out water from the BLIP primary system). The waste tank and its associated piping system conform to Article 12 requirements and are registered with the SCDHS.

In 1998, BNL conducted an extensive evaluation of groundwater quality near the BLIP facility. Tritium concentrations of 52,000 pCi/L and sodium-22 up to 151 pCi/L were detected in the groundwater approximately 50 feet downgradient of the BLIP target vessel. Due to the activation of the soil shielding surrounding the BLIP target vessel and the detection of tritium and sodium-22 in groundwater, the BLIP facility was designated as sub-AOC 16K under the IAG.

In 1998, BNL made improvements to the stormwater management program at BLIP in an effort to prevent additional rainwater infiltration into the activated soil below the building. The BLIP building's roof drains were redirected away from the building, existing paved areas on the south side of the building were resealed, and a gunite cap was installed on the remaining three sides of the building. In May and June 2000, BNL undertook additional protective measures by injecting colloidal silica grout (also known as a Viscous Liquid Barrier) into the activated soil. The grout reduces the permeability of the soil, thus further reducing the ability of rainwater to leach tritium and sodium-22 from the activated soils should the stormwater controls fail.

In late 2004, BNL also constructed a new protective cap over the beam line that runs from the Linac to the BLIP facility. The new cap was installed because direct soil measurements and beam loss calculations indicated that the tritium and sodium-22 concentrations in soils surrounding these beam lines could result in stormwater leachate concentrations that exceed the criteria described in the *Accelerator Safety* SBMS (Standards Based Management System) subject area.[2]

Following concurrence from the NYSDEC, a ROD was signed by the DOE and EPA in early 2007 (BNL 2007b). This ROD requires continued routine inspection and maintenance of the impermeable cap, and groundwater monitoring to verify the continued effectiveness of the stormwater controls. Maintenance of the cap and groundwater monitoring will continue for as long as the activated soils remain a threat to groundwater quality.

4.3.1 BLIP Groundwater Monitoring

Well Network

The monitoring well network for the BLIP facility consists of two upgradient (054-61 and 064-46) and five downgradient wells (064-47 through 064-50, and 064-67). These wells provide a means of verifying that the engineered and administrative controls described above are effective in protecting groundwater quality (**Figure 4-1**).

Sampling Frequency and Analysis

During 2009, one upgradient (064-46) and the five downgradient monitoring wells were monitored twice, and the groundwater samples were analyzed for tritium (**Table 1-6**).

4.3.2 BLIP Monitoring Well Results

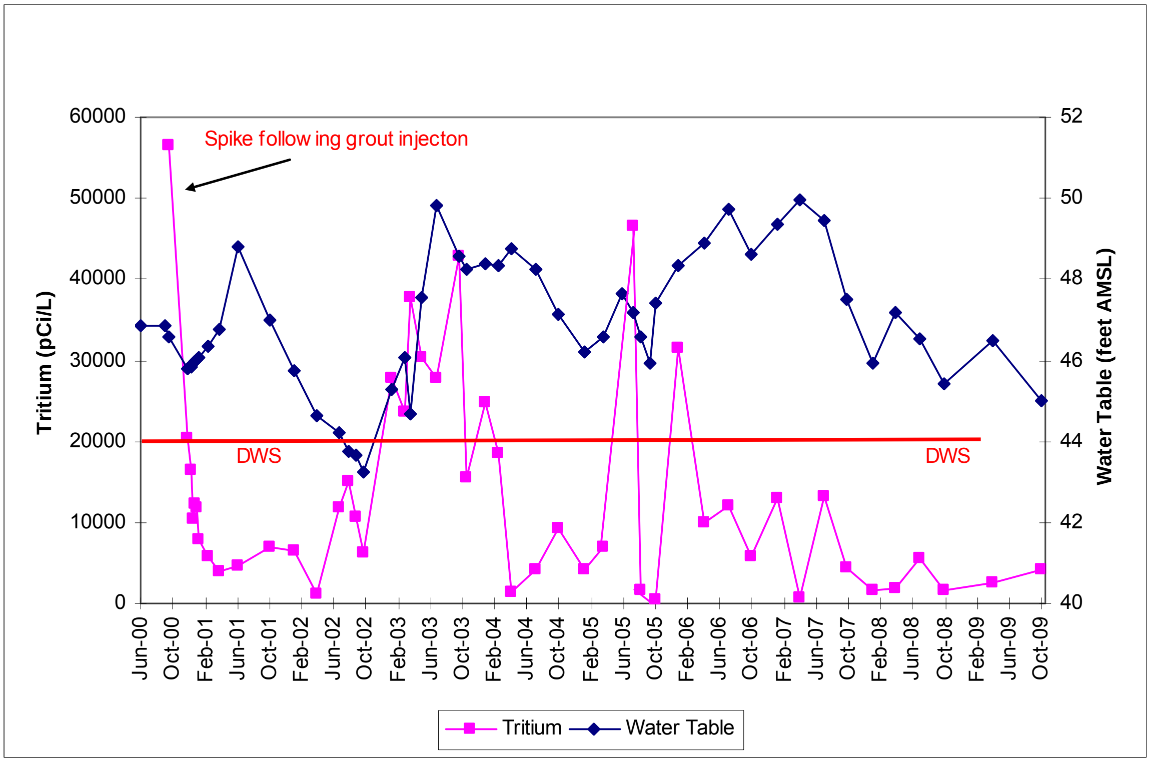
Monitoring data collected from January 1999 to July 2000 indicated that the initial corrective actions taken during 1998 were highly effective in preventing the release of tritium and sodium-22 from the activated soil surrounding the BLIP target vessel. Prior to May 2000, tritium and sodium-22 concentrations in wells directly downgradient of BLIP were <3,000 pCi/L and <5 pCi/L, respectively. However, significant increases in tritium concentrations were observed in groundwater samples collected after the silica grout injection took place in late May and early June 2000 (**Figure 4-11**). It was determined that tritium in the soil pore water near the target vessel was displaced by the grout. Tritium concentrations in the groundwater immediately downgradient of BLIP increased to 56,500 pCi/L by October 2000. By December 2000, tritium concentrations dropped to below 20,000 pCi/L, and remained below this level throughout 2001 and 2002. From 2003 through January 2006, there were

---

[2] The BNL *Accelerator Safety* SBMS subject area requires stormwater controls where rainwater infiltration into activated soil shielding could result in leachate concentrations that exceed five percent of the drinking water standard for tritium (i.e., 1,000 pCi/L) or sodium-22 (i.e., 20 pCi/L). In early 2010, a BNL management waiver was granted to increase the limit for sodium-22 in leachate to 25% of the drinking water standard (i.e., 100 pCi/L).

several short-duration periods when tritium concentrations once again exceeded 20,000 pCi/L. Since April 2006, tritium levels have remained below the 20,000 pCi/L DWS. During 2009, the maximum tritium concentration was 4,240 pCi/L.

Figure 4-11.
BLIP Facility
Tritium Concentrations vs. Water-Table Position, in Wells 40 Feet Downgradient,



Note: Approximate groundwater travel time from directly below the BLIP target to the first set of monitoring wells (e.g., well 064-67) is approximately 89 days, based on a distance of 40 feet and groundwater velocity of 0.45 ft/day.

4.3.3 BLIP Groundwater Monitoring Program Evaluation

The BLIP cap is in good condition, and is effectively controlling stormwater infiltration. Although direct inspection 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 should the primary stormwater controls fail. The short-term concentration increases observed in 2005 and 2006 correlated to increases in the elevation of the water table (**Figure 4-11**). As the water table rises, older tritium that had leached from the soil before the cap was installed in 1998 or that was released during the grout injection project is flushed from the soil close to the water table. The amount of tritium remaining in the vadose zone close to the water table is expected to decline over time, due to this flushing mechanism and by natural radioactive decay. Although the water table has increased to nearly 50 feet AMSL several times since 2006, there has not been a corresponding increase in tritium concentrations. This suggests that the amount of tritium available to be flushed from the deep vadose zone by fluctuations in water-table position has decreased.

4.3.4 BLIP Recommendation

As required by the ROD, BNL will continue to conduct routine inspections of the cap, and to monitor groundwater quality downgradient of the BLIP facility. The following is recommended for the BLIP groundwater monitoring program:

- Because tritium levels in groundwater have been continuously below the 20,000 pCi/L DWS since January 2006, the monitoring frequency for the downgradient monitoring wells 064-47, 064-48, and 064-67 will continue to be semiannually.
- Sampling frequency for the two upgradient (054-61 and 064-46) and two downgradient wells (064-49 and 064-50) will be reduced from semiannual to annual.

4.4 Relativistic Heavy Ion Collider (RHIC)

Beam line interaction with the Relativistic Heavy Ion Collider (RHIC) Collimators and Beam Stops produces secondary particles that interact with soil surrounding the 8 o'clock and 10 o'clock portions of the RHIC tunnel and the W-Line Stop (**Figure 4-12**). These interactions result in the production of tritium and sodium-22, which can be leached out of the soil by rainwater. Although the level of soil activation was expected to be minor, before RHIC operations began in 2000 BNL installed impermeable caps over these beam loss areas to prevent potential impact to groundwater quality.

4.4.1 RHIC Groundwater Monitoring

Well Network

Thirteen shallow wells are used to verify that the engineered impermeable caps and operational controls implemented at the RHIC beam stops and collimators are effective in protecting groundwater quality. Six of the monitoring wells are located in the 10 o'clock Beam Stop area, six wells are in the collimator area, and one well is downgradient of the W-Line Beam Stop (**Figure 4-12**). As part of BNL's Environmental Surveillance program, surface water samples are also collected from the Peconic River, both upstream (location HY) and downstream (location HV) of the Beam Stop area. These monitoring results are used to verify that potentially contaminated groundwater is not being discharged into the Peconic River stream bed during high water-table conditions.

Sampling Frequency and Analysis

During 2009, groundwater samples were collected from the RHIC monitoring wells on a semiannual schedule, and the samples were analyzed for tritium (**Table 1-6**). Routine analysis for sodium-22 was dropped from the groundwater monitoring program in 2002 because tritium is the best indicator of possible cap failure (i.e., tritium is more leachable than sodium-22, and it migrates at the same rate as groundwater). Surface water samples were collected quarterly and were analyzed for tritium and gamma emitting radionuclides (such as sodium-22).

4.4.2 RHIC Monitoring Well Results

As in past years, no tritium was detected in the RHIC groundwater samples. No tritium or sodium-22 was detected in surface water samples from downstream location HV.

4.4.3 RHIC Groundwater Monitoring Program Evaluation

Groundwater and surface water monitoring data continue to demonstrate that the impermeable caps installed over the RHIC Beam Stop and Collimator areas are effectively preventing rainwater infiltration into the activated soil shielding.

4.4.4 RHIC Recommendation

The following is recommended for the RHIC groundwater monitoring program:

- During 2010, groundwater samples will continue to be collected on a semiannual basis. Surface water samples will also continue to be collected quarterly as part of the monitoring program.

4.5 Brookhaven Medical Research Reactor (BMRR)

The Brookhaven Medical Research Reactor (BMRR) was a 3-megawatt light water reactor that was used for biomedical research. Research operations at the BMRR stopped in December 2000. All spent fuel was removed in 2003 and the primary cooling water system has been drained. BNL is preparing plans to permanently decommission the facility.

The BMRR primary cooling water system consisted of a recirculation piping system that contained 2,550 gallons of water. The cooling water contained approximately 5 curies (Ci) of tritium. Unlike the HFBR, the BMRR does not have a spent fuel storage canal or pressurized imbedded piping systems that contained radioactive liquids. Historically, fuel elements that required storage were either stored within the reactor vessel, or they were transferred to the HFBR spent fuel canal. The BMRR primary cooling water system piping is fully exposed in the containment structure and is accessible for routine visual inspections. When the BMRR was operational, excess heat was transferred by means of heat exchangers with once-through (secondary) cooling water, which was obtained from nearby process supply wells or the BNL Chilled Water System. This secondary water was discharged to recharge basin HP, 800 feet south of the Medical Department complex, and was monitored as part of the SPDES program. All cooling water discharges from the BMRR stopped in December 2000.

In 1997, tritium was detected in wells installed directly downgradient (within 30 feet) of the BMRR. The maximum tritium concentration observed during 1997 was 11,800 pCi/L, almost one-half of the 20,000 pCi/L DWS. The highest observed tritium concentration since the start of groundwater monitoring was 17,100 pCi/L in October 1999. The tritium currently detected in groundwater is believed to have originated from the historical discharge of small amounts of BMRR primary cooling water to a basement floor drain and sump system that may have leaked. Although the last discharge of primary cooling water to the floor drain system occurred in 1987, the floor drains continued to be used for secondary (non-radioactive) cooling water until 1997. The infiltration of this water may have promoted the movement of residual tritium from the soil surrounding the floor drain piping system to the groundwater. The floor drains were permanently sealed in 1998 to prevent any accidental future releases to the underlying soil.

4.5.1 BMRR Groundwater Monitoring

Well Network

The monitoring well network for the BMRR facility consists of one upgradient and three downgradient wells (**Figure 4-13**). Samples collected from the four groundwater monitoring wells are used to determine whether residual tritium in the soils below the BMRR is impacting groundwater quality.

Sampling Frequency and Analysis

Starting in 2007, the sampling frequency for the BMRR wells was changed from annual to once every two years. One set of samples was collected in 2008, and the samples were analyzed for tritium, gamma emitting radionuclides, gross alpha, and gross beta. No samples were collected during 2009 (**Table 1-6**).

4.5.2 BMRR Monitoring Well Results

Although samples were not collected during 2009, monitoring results for the past years indicate that tritium concentrations are well below the 20,000 pCi/L DWS (**Figure 4-14**). As in past years, gamma, gross alpha, and gross beta analyses did not indicate the presence of any other reactor-related radionuclides.

4.5.3 BMRR Groundwater Monitoring Program Evaluation

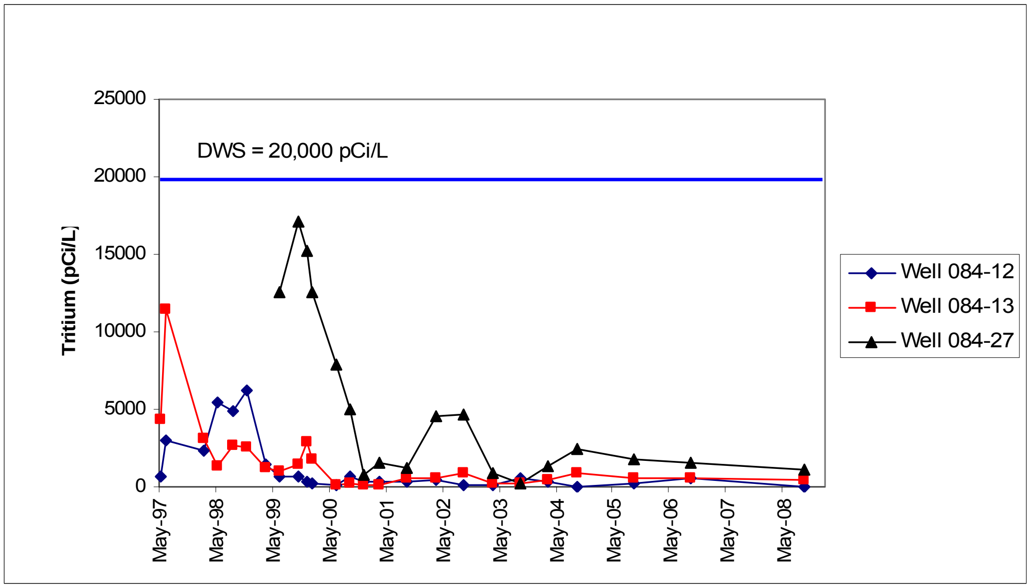
Tritium concentrations in groundwater from the BMRR well network have never exceeded the 20,000 pCi/L DWS, and have remained <5,000 pCi/L since September 2000. The BMRR structure is effectively preventing rainwater infiltration into the underlying soils, and therefore reducing the movement of any residual tritium from the soil to the groundwater.

4.5.4 BMRR Recommendation

The following is recommended for the BMRR groundwater monitoring program:

- The monitoring frequency for the BMRR wells will continue to be once every two years, with the next set of samples being collected in 2010.

Figure 4-14.
BMRR
Tritium Concentrations in Downgradient Wells



4.6 Sewage Treatment Plant (STP)

The STP processes sanitary wastewater from BNL research and support facilities. Treated effluent from the STP is discharged to the Peconic River under a NYSDEC SPDES permit (NY-0005835). On average, 0.5 million gallons per day (MGD) are processed during the summer and 0.3 MGD are processed daily during the rest of the year. Before discharge into the Peconic River, the sanitary waste stream is fully treated by 1) primary clarification to remove settleable solids and floatable materials, 2) aerobic oxidation for secondary removal of the biological matter and nitrification of ammonia, 3) secondary clarification, 4) sand filtration for final effluent polishing, and 5) ultraviolet disinfection for bacterial control. Oxygen levels are regulated during the treatment process to remove nitrogen biologically, using nitrate-bound oxygen for respiration.

Wastewater from the STP clarifier is released to the sand filter beds, where water percolates through 3 feet of sand before being recovered by an underlying clay tile drain system, which transports the water to the discharge point at the Peconic River (SPDES Outfall 001). Approximately 15 percent of the water released to the filter beds is either lost to evaporation or to direct groundwater recharge. At the present time, six sand filter beds are used in rotation.

Two emergency hold-up ponds are located east of the sand filter bed area. The hold-up ponds are used to store sanitary waste in the event of an upset condition or if the influent contains contaminants in concentrations exceeding BNL administrative limits and/or SPDES permit effluent release criteria. The hold-up ponds have a combined holding capacity of nearly 8 million gallons of water, and provide BNL with the ability to divert all sanitary system effluent for approximately one week. The hold-up ponds are equipped with fabric-reinforced plastic liners that are heat-welded along all seams. As part of the Phase III Sewage Treatment Plant Upgrades project in 2001, the liners were enhanced by the addition of new primary liners and a leak detection system. The older liners now serve as secondary containment.

4.6.1 STP Groundwater

Well Network

In addition to the comprehensive influent and effluent monitoring program at the STP, the groundwater monitoring program is designed to provide a secondary means of verifying that STP operations are not impacting environmental quality. Six wells (038-02, 038-03, 039-07, 039-08, 039-86, and 039-87) are used to monitor groundwater quality in the Filter Bed area, and three wells (039-88, 039-89, and 039-90) are monitored in the Holding Pond area (**Figure 4-15**).

Sampling Frequency and Analysis

The six STP Filter Bed and three Holding Pond area monitoring wells are usually sampled once each year (normally in December). However, due to weather related scheduling problems, the wells were sampled during the first week of January 2010. The samples from the Filter Bed area wells were analyzed for VOCs, anions (sulfate, chloride, and nitrate), metals, tritium, gross alpha, gross beta, and gamma emitting radionuclides and the wells positioned downgradient of the holding ponds were analyzed for VOCs, tritium, gross alpha, gross beta, and gamma emitting radionuclides (**Table 1-6**). To evaluate mercury levels in the filter bed area, samples were also collected from three wells (038-02, 039-86, and 039-87) in February 2009. During this period, filtered and unfiltered samples were analyzed for metals, including analyses for low-level mercury.

4.6.2 STP Monitoring Well Results

Radiological Analyses

Gross alpha and gross beta levels in samples collected from the STP wells were generally typical of ambient (background) levels. Tritium was not detected in any of the STP area wells, and no BNL-related gamma emitting radionuclides were detected in any of the STP groundwater monitoring wells.

Non-Radiological Analyses

All water quality and most metals concentrations were below the applicable NYS AWQS. Slightly elevated metals were detected in unfiltered groundwater samples collected from several Filter Bed area wells. Both the February 2009 and January 2010 samples from well 039-86 had sodium levels slightly above the 20 milligram per liter (mg/L) NYS AWQS, with concentrations of 35.5 and 23.4 mg/L, respectively. In the February 2009 sample from well 038-02, iron, aluminum and thallium levels exceeded the applicable standards, with levels of 17.9 mg/L, 12.6 mg/L and 0.0006 mg/L, respectively. The NYS AWQS for iron is 0.3 mg/L, the DWS (secondary MCL for aesthetic quality) for aluminum is 0.2 mg/L, and the AWQS for thallium is 0.0005 mg/L. In February 2009 and January 2010, low-level mercury analyses were also performed on samples collected from several of the Filter Bed area wells. Results of the low-level analyses indicated a maximum mercury concentration of 9.4 ng/L detected in well 038-02. The NYS AWQS for mercury is 700 ng/L. Low levels of nitrates continue to be detected in many of the STP Filter Bed area wells, with a maximum concentration of 4.6 mg/L detected in monitoring well 039-86. The NYS AWQS for nitrate is 10 mg/L. No VOCs were detected above the NYS AWQS in any of the STP monitoring wells.

4.6.3 STP Groundwater Monitoring Program Evaluation

Monitoring results for 2009 indicate that STP operations are not having a significant impact on groundwater quality, and that the BNL administrative and engineered controls designed to prevent the discharge of chemicals and radionuclides to the sanitary system continues to be effective.

4.6.4 STP Recommendation

No changes to monitoring frequency or analyses are proposed for 2010.

4.7 Motor Pool Maintenance Area

The Motor Pool (Building 423) and Site Maintenance facility (Building 326) are attached structures located along West Princeton Avenue (**Figure 4-16**). The Motor Pool area consists of a five-bay automotive repair shop, which includes office and storage spaces. The Site Maintenance facility provides office space, supply storage, locker room, and lunchroom facilities for custodial, grounds, and heavy equipment personnel. Both facilities have been used continuously since 1947.

Potential environmental concerns at the Motor Pool include 1) the historical use of USTs to store gasoline, diesel fuel, and waste oil, 2) hydraulic fluids used for lift stations, and 3) the use of solvents for parts cleaning. In August 1989, the gasoline and waste oil USTs, pump islands, and associated piping were upgraded to conform to Suffolk County Article 12 requirements for secondary containment, leak detection devices, and overfill alarms. Following the removal of the old USTs, there were no obvious signs of soil contamination. The present tank inventory includes two 8,000-gallon USTs used to store unleaded gasoline, one 260-gallon above ground storage tank used for waste oil, and one 3,000-gallon UST for No. 2 fuel oil. The Motor Pool facility has five vehicle-lift stations. The hydraulic fluid reservoirs for the lifts are located above ground.

Since 1996, several small-scale hydraulic oil and diesel oil spills have been remediated at the Motor Pool. The only known environmental concern associated with the Site Maintenance facility (Building 326) was the December 1996 discovery of an old oil spill directly south of the building. In an effort to investigate the potential impact that this spill had on groundwater quality, four wells were installed downgradient of the spill site. Although the solvent TCA was detected in the groundwater at concentrations above NYS AWQS, petroleum hydrocarbons were not detected.

4.7.1 Motor Pool Maintenance Area Groundwater Monitoring

Well Network

The Motor Pool facility's groundwater monitoring program for the UST area is designed to confirm that the engineered and institutional controls are effective in preventing contamination of the aquifer, and to evaluate continued impacts from historical spills. Two shallow Upper Glacial aquifer wells (102-05 and 102-06) are used to monitor for potential contaminant releases from the UST area (**Figure 4-16**).

Groundwater quality downgradient of Building 423 and Building 326 is monitored using four wells (102-10, 102-11, 102-12, and 102-13). The program is designed to periodically assess existing solvent contamination that resulted from historical vehicle maintenance operations, and to confirm that the current engineered and institutional controls are effective in preventing additional contamination of the aquifer.

Sampling Frequency and Analysis

During 2009, the UST area wells were monitored semiannually and the samples were analyzed for VOCs (**Table 1-6**). The wells were also checked for the presence of floating petroleum hydrocarbons during these sample periods. The Building 423/326 area wells were also monitored semi-annually, and the samples were analyzed for VOCs.

4.7.2 Motor Pool Monitoring Well Results

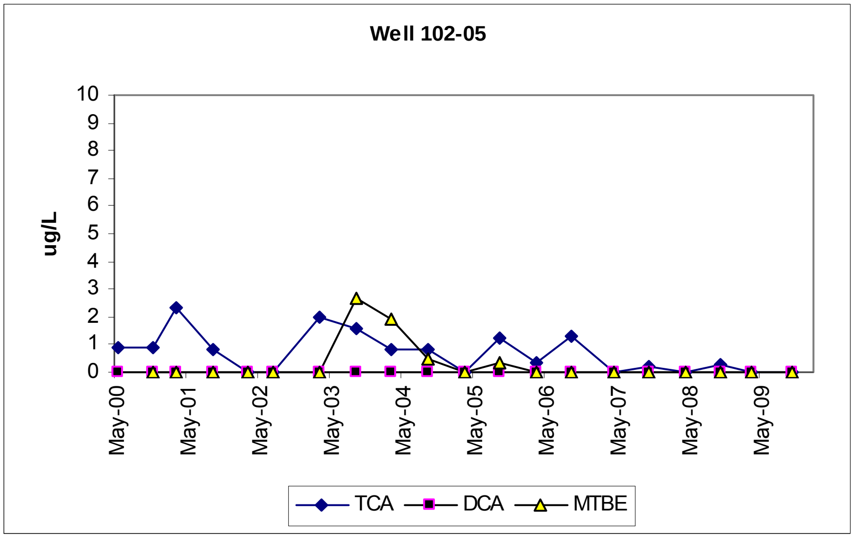
Underground Storage Tank Area

During 2009, no gasoline-related products were detected in groundwater downgradient of the gasoline UST area (**Figure 4-17**). Although the former gasoline additive MTBE concentrations had reached a maximum of nearly 34 µg/L in 2003, MTBE has not been detected in any samples since 2006. The NYS Ambient Water Quality Guidance Value for MTBE is 10 µg/L. As in past years, trace levels of the solvent TCA were also detected, but at concentrations that continued to be well below the NYS AWQS of 5 µg/L. As in previous years, no floating product was observed in the monitoring wells.

Building 423/326 Area

During 2009, the solvent TCA was detected in well 102-11 at a concentration of 6.5 µg/L, slightly above the 5 µg/L NYS AWQS (**Figure 4-18**). As in 2007 and 2008, DCA levels remained less than the 5 µg/L standard. The gasoline additive MTBE was not detected in any of the Motor Pool wells. It is believed that the TCA and DCA originated from historical vehicle maintenance operations.

Figure 4-17.
Motor Pool Gasoline UST Area
VOC Concentration Trends in Downgradient Wells



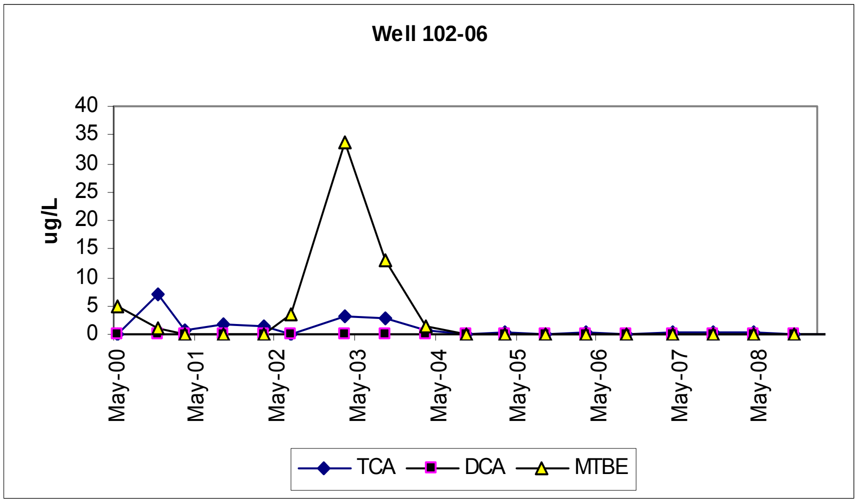
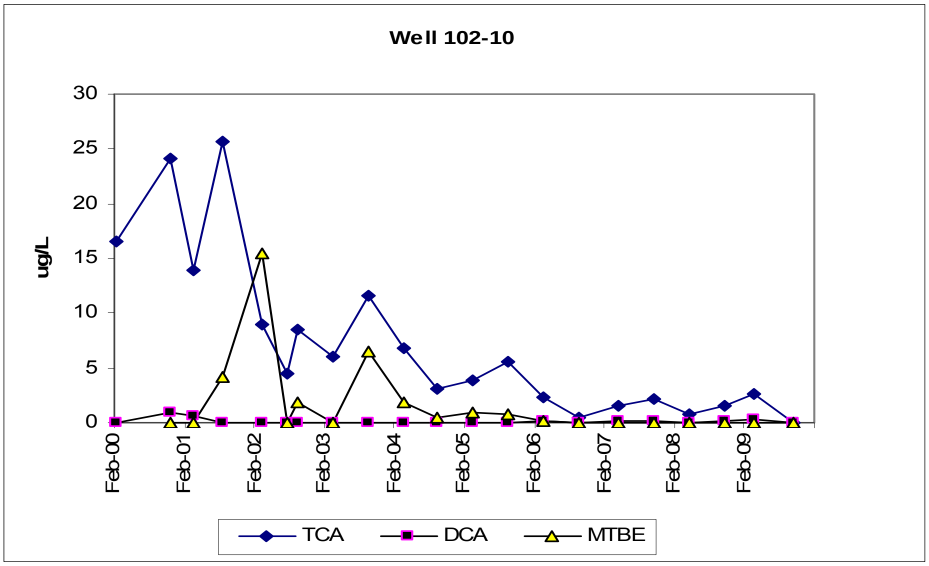
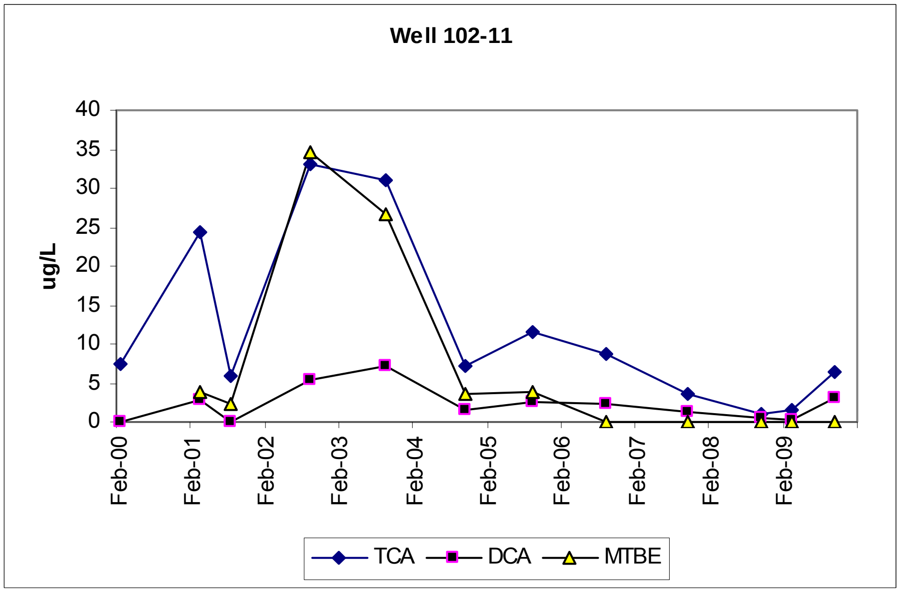
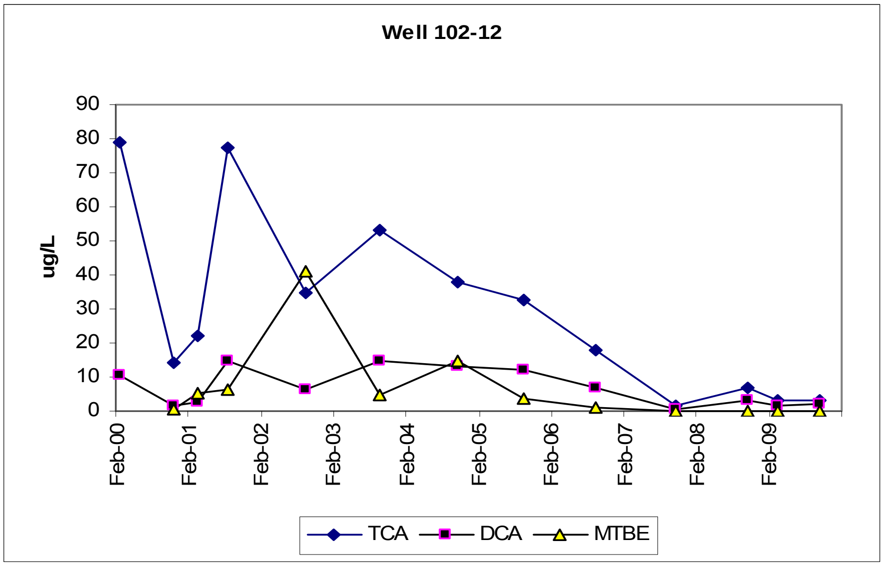
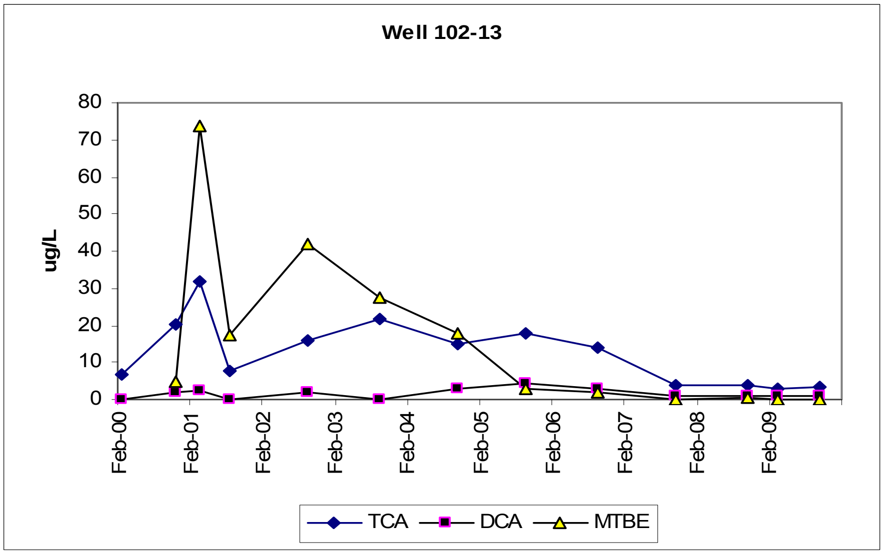

Well 102-06
ug/L
40
35
30
25
20
15
10
5
0
May-00
May-01
May-02
May-03
May-04
May-05
May-06
May-07
May-08
TCA
DCA
MTBE

Figure 4-18.
Motor Pool Building 423/326 Area
VOC Concentration Trends in Downgradient Wells









4.7.3 Motor Pool Groundwater Monitoring Program Evaluation

Although small-scale solvent and gasoline releases from vehicle maintenance operations have impacted groundwater quality in the Motor Pool area, there has been a steady decrease in VOC concentrations over the past several years. During 2009 there were no reported gasoline or motor oil losses or spills that could affect groundwater quality, and all waste oils and used solvents generated from current operations are being properly stored and recycled. The gasoline USTs have electronic leak detection systems, and there is a daily product reconciliation (i.e., an accounting of the volume of gasoline stored in USTs and volume of gasoline sold). The MTBE and TCA that is periodically detected in the groundwater near the UST area are likely to have originated from historical spills.

4.7.4 Motor Pool Recommendation

No changes to the monitoring program are proposed for 2010.

4.8 On-Site Service Station

Building 630 is a commercial automobile service station, privately operated under a contract with BNL. The station was built in 1966, and is used for automobile repair and gasoline sales. Potential environmental concerns at the Service Station include the historical use of USTs for the storage of gasoline and waste oil, hydraulic fluids used for lift stations, and the use of solvents for parts cleaning. When the Service Station was built in 1966, the UST inventory consisted of one 6,000-gallon and two 8,000-gallon tanks for storing gasoline, and one 500-gallon tank for used motor oil. In August 1989, the USTs, pump islands, and associated piping were upgraded to conform to Suffolk County Article 12 requirements for secondary containment, leak detection devices, and overfill alarms. During the removal of the old USTs, there were no obvious signs of soil contamination.

The current tank inventory includes three 8,000-gallon USTs for storing unleaded gasoline and one 500-gallon UST used for waste oil. The facility has three hydraulic vehicle-lift stations.

Groundwater quality in the Service Station area has been impacted by historical small-scale spills of oils, gasoline, and solvents, and by carbon tetrachloride contamination associated with a nearby UST that was used as part of a science experiment conducted in the 1950s. In April 1998, BNL removed a UST from an area approximately 200 feet northwest (upgradient) of the service station. Although there are indications that the tank was releasing small quantities of carbon tetrachloride before its removal, a significant increase in carbon tetrachloride concentrations in groundwater indicated that additional amounts of this chemical were inadvertently released during the excavation and removal process. BNL started to remediate the carbon tetrachloride plume in October 1999 (**Section 3.2.1**).

4.8.1 Service Station Groundwater Monitoring

Well Network

The service station's groundwater monitoring program is designed to confirm that the engineered and institutional controls in place are effective in preventing contamination of the aquifer and to evaluate continued impacts from historical spills. Five wells are used to monitor for potential contaminant releases (**Figure 4-19**).

Sampling Frequency and Analysis

During 2009, the service station facility wells were monitored two times, and the samples were analyzed for VOCs (**Tables 1-5** and **1-6**). Three of the wells near the gasoline USTs were also checked semiannually for the presence of floating petroleum hydrocarbons.

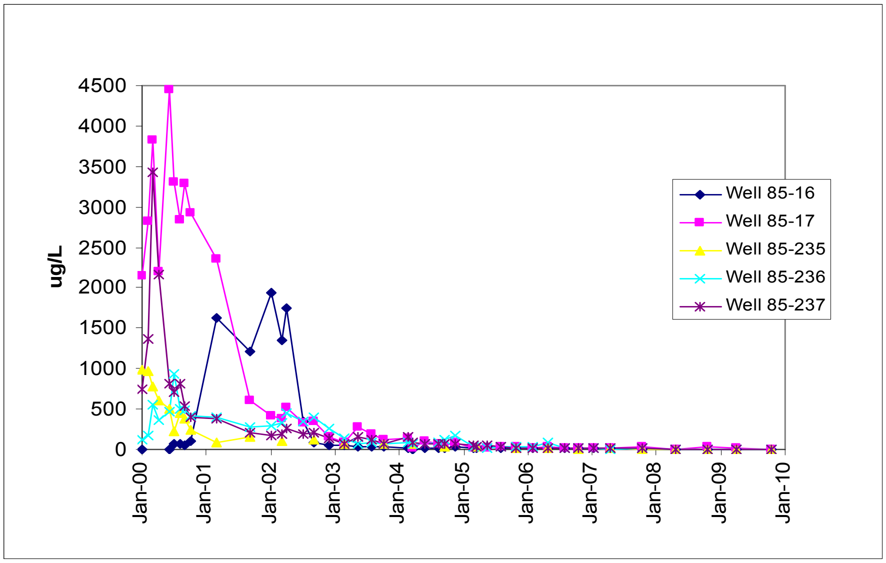
4.8.2 Service Station Monitoring Well Results

During 2009, carbon tetrachloride (and its breakdown product, chloroform) continued to be detected in the Service Station monitoring wells (**Figure 4-20**). The maximum carbon tetrachloride and chloroform concentrations were 13 μg/L and 5.9 μg/L, respectively. Carbon tetrachloride only exceeded its NYS AWQS of 5 μg/L in one well, 085-17. All chloroform detections were at concentrations below its NYS AWQS of 7 μg/L. The levels of carbon tetrachloride currently detected in the groundwater are considerably less than those observed during 2000, when carbon tetrachloride concentrations approached 4,500 μg/L. The reduction in carbon tetrachloride levels reflects the effectiveness of the groundwater remediation system, which achieved its cleanup objectives and was shut down and placed in standby mode in August 2004, and is currently scheduled for full decommissioning (**Section 3.2.1**).

Historically, groundwater quality at the Service Station has been affected by a variety of VOCs that appeared to be related to historical Service Station operations. During 2009, high levels of VOCs (with a TVOC concentration of 618 μg/L) continued to be detected in well 085-17. The contamination consisted primarily of xylenes (total) at 350 μg/L, 1,2,4-trimethylbenzene at 120 μg/L, 1,3,5-trimethylbenzene at 56 μg/L, and the solvent PCE at a concentration of 23 μg/L (**Figure 4-21**). VOC concentrations in wells 085-235, 085-236, and 085-237 have remained at low to trace levels (**Figures 4-**

22 and **4-23**). As in previous years, no floating product was detected in the wells. It is important to note that the petroleum-related compounds detected in the Motor Pool wells have not been detected in Carbon Tetrachloride project wells located downgradient of the facility. This is consistent with studies that have demonstrated that many petroleum-related compounds breakdown in aquifer systems within a short distance from a source area.

Figure 4-20.
Service Station
Carbon Tetrachloride Concentration Trends in Monitoring Wells.



4.8.3 Service Station Groundwater Monitoring Program Evaluation

Analysis of groundwater samples collected at the Service Station facility during 2009 indicates that VOCs continue to be detected at concentrations greater than the applicable NYS AWQS. There were no reported gasoline or motor oil losses or spills that could affect groundwater quality, and all waste oils and used solvents generated from current operations are being properly stored and recycled. The gasoline USTs have electronic leak detection systems, and there is a daily product reconciliation (i.e., an accounting of the volume of gasoline stored in USTs and volume of gasoline sold). It is believed that the petroleum hydrocarbon-related compounds and solvents that have been detected in groundwater originated from historical vehicle maintenance operations before improved chemical storage and handling controls were implemented in the 1980s.

Figure 4-21.
Service Station
Trend of Service Station-Related VOCs in Downgradient Well 085-17
Carbon tetrachloride originating from the upgradient carbon tetrachloride UST source area is not included.

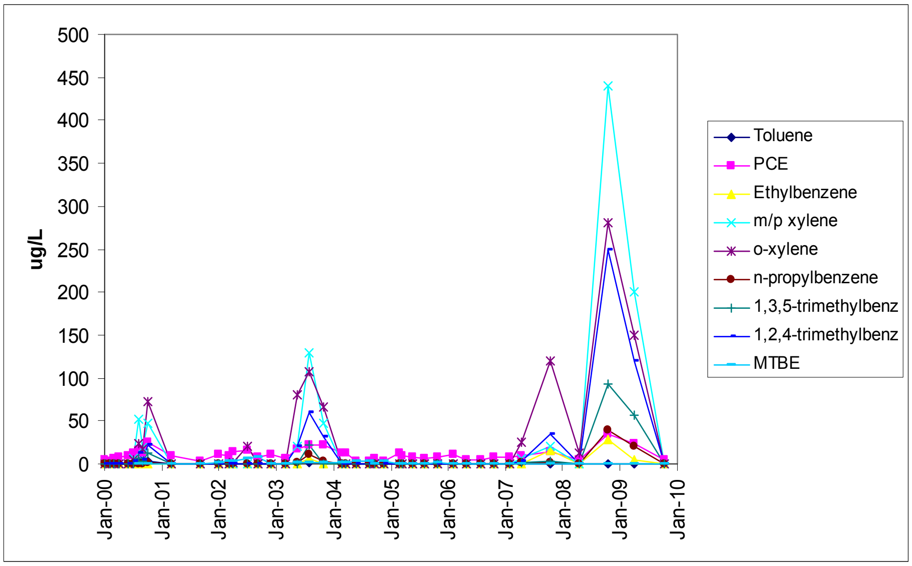
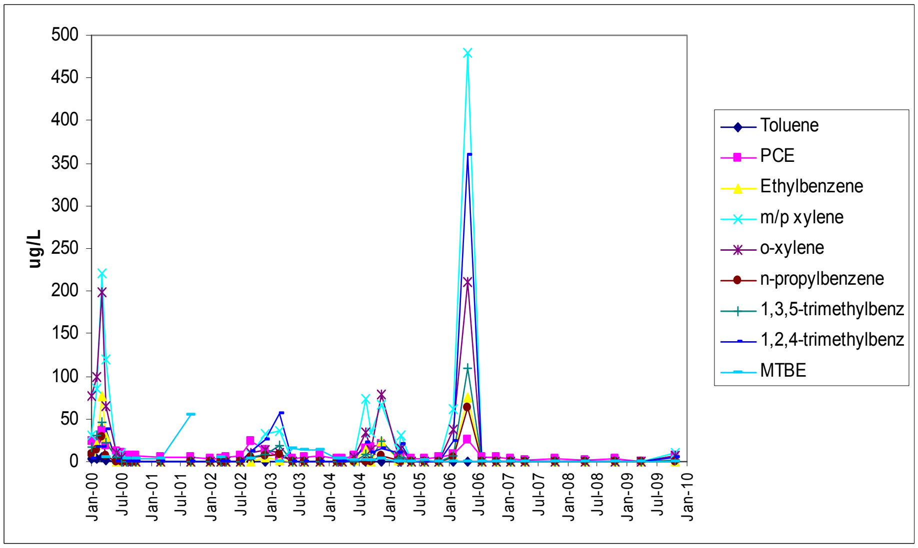


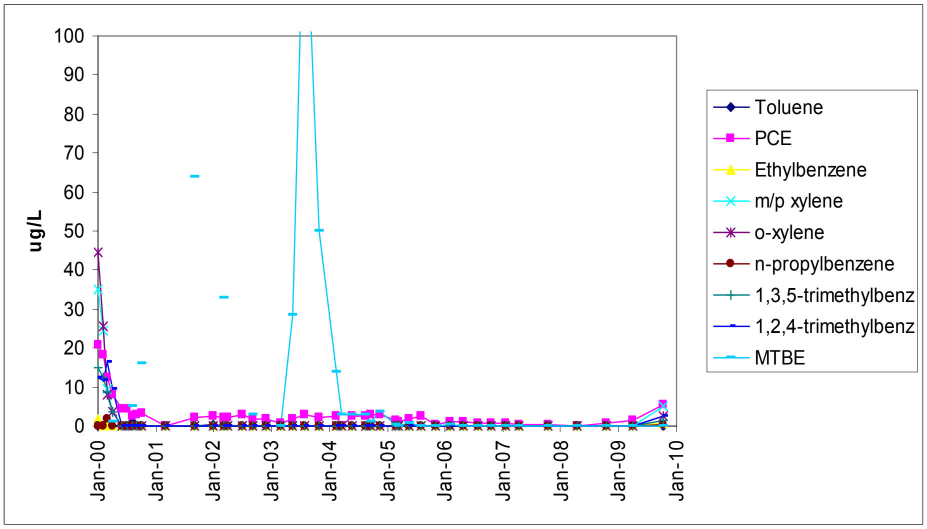
Figure 4-22.
Service Station
Trend of Service Station-Related VOCs in Downgradient Well 085-236
Carbon tetrachloride from the upgradient carbon tetrachloride UST source area is not included.



4.8.4 Service Station Recommendation

No changes to the monitoring program are proposed for 2010.

Figure 4-23.
Service Station
Trend of Service Station-Related VOCs in Downgradient Well 085-237
Carbon tetrachloride originating from the upgradient carbon tetrachloride UST source area is not included.



4.9 Major Petroleum Facility (MPF) Area

The MPF is the holding area for fuel oil used at the Central Steam Facility (CSF). The fuel oil is held in a network of seven above ground storage tanks, which have a combined capacity of up to 1.7 million gallons of No. 6 fuel oil and 60,000 gallons of No. 2 fuel oil. The tanks are connected to the CSF by above ground pipelines that have secondary containment and leak detection devices. The fuel storage tanks are positioned in bermed containment areas that have a capacity to hold >110 percent of the volume of the largest tank located there. The bermed areas have bentonite clay liners consisting of either Environmat^{TM} (bentonite clay sandwiched between geotextile material) or bentonite clay mixed into the native soil to form an impervious soil/clay layer. As of December 1996, the fuel-unloading operations were consolidated to one centralized building that has secondary containment features. The MPF is operated under NYSDEC Permit #1-1700 and, as required by law, a Spill Prevention Control and Countermeasures (SPCC) Plan and a Facility Response Plan have been developed for the facility. Groundwater quality near the MPF has been impacted by several oil and solvent spills: 1) the 1977 fuel oil/solvent spill east of the MPF that was remediated under the IAG (**Section 3.3.1**); and 2) solvent spills near the CSF.

4.9.1 MPF Groundwater Monitoring

Well Network

Eight shallow Upper Glacial aquifer wells are used to confirm that the engineered and institutional controls in place are effective in preventing contamination of the aquifer (**Figure 4-24**).

Sampling Frequency and Analysis

Groundwater contaminants from the fuel oil products stored at the MPF can travel both as free product and in dissolved form with advective groundwater flow. Historically, the Special License Conditions for the MPF required semiannual sampling for SVOCs and monthly monitoring for floating petroleum. Samples were also periodically tested for VOCs as part of the Facility Monitoring Program. In 2002, NYSDEC expanded the required list of routine analyses to include VOCs, including testing for

MTBE (**Table 1-6**). MTBE was a common gasoline additive until January 2004, and it was occasionally introduced to fuel oil as a contaminant during the storage and transportation process.

4.9.2 MPF Monitoring Well Results

The MPF wells were monitored monthly for the presence of floating petroleum, and were sampled in April and October 2009. The samples were analyzed for SVOCs and VOCs. As in the past, no SVOCs were detected, and no floating product was observed. A number of VOCs not associated with fuel storage activities continued to be detected in the MPF area wells. The highest VOC concentrations continue to be detected in well 076-380, where PCE was detected at concentrations up to 69 μg/L, well above the NYS AWQS of 5 μg/L. TCE (6.3 μg/L) was detected above its standard of 5 μg/L and low levels of TCA (up to 2.6 μg/L) were also detected in this well. Levels of the PCE breakdown product trans-1,2-dichloroethylene (1,2-DCE) dropped to trace to non-detectable levels by the end of 2005 (**Figure 4-25**). Elevated levels of VOCs were also detected in OU IV monitoring well 076-185, located approximately 300 feet downgradient of well 076-380, with PCE concentrations up to 23 μg/L and PCE breakdown product cis-1,2-DCE at concentrations up to 19 μg/L. These solvents are believed to have originated from documented historical spills near the CSF building; their presence in groundwater is not the result of recent CSF or MPF operations.

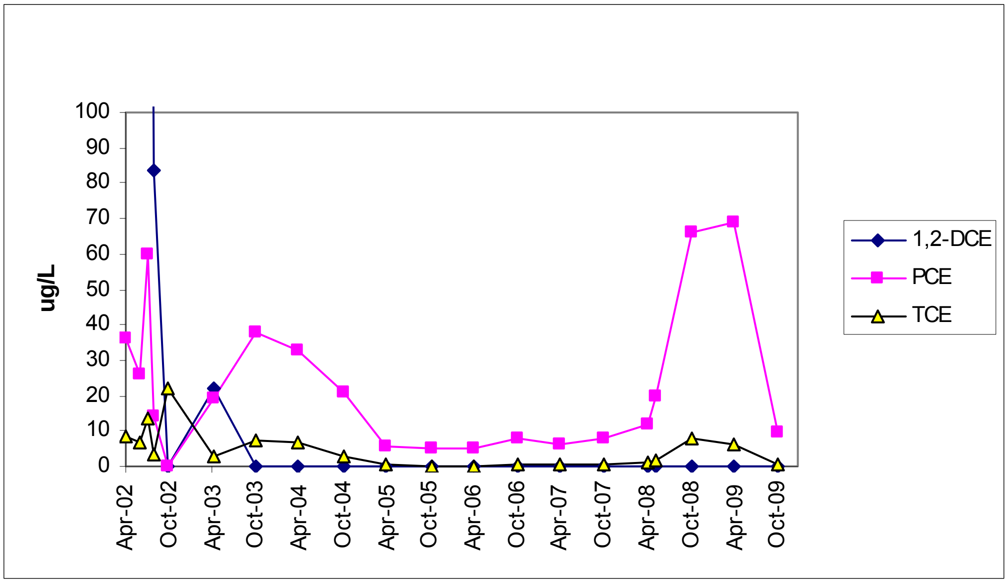
4.9.3 MPF Groundwater Monitoring Program Evaluation

Groundwater monitoring at the MPF continues to show that fuel storage and distribution operations are not impacting groundwater quality. The low levels of PCE and TCE detected in the groundwater in 2009 are likely to have originated from historical solvent spills near the Central Steam Facility (Building 610) (**Figure 4-24**). The historical nature of this contamination is supported by: 1) degreasing agents such as PCE have not been used at the CSF in many years, 2) PCE has been detected in several MPF area wells since the early 1990s, and 3) breakdown products of PCE have been detected. A number of historical spill sites near the CSF were identified in the late 1990s, and the contaminated soil was excavated in accordance with regulatory requirements.

4.9.4 MPF Recommendation

For 2010, monitoring will continue as required by the NYS operating permit.

Figure 4-25.
Major Petroleum Facility
VOC Concentrations in Downgradient Well 076-380.



4.10 Waste Management Facility (WMF)

The WMF is designed to safely handle, repackage, and temporarily store BNL-derived wastes prior to shipment to off-site disposal or treatment facilities. The WMF is a state-of-the-art facility, with administrative and engineered controls that meet all applicable federal, state, and local environmental protection requirements. The WMF consists of four buildings: the Operations Building, Reclamation Building (for radioactive waste), RCRA Building, and the Mixed Waste Building.

Groundwater monitoring is a requirement of the RCRA Part B permit issued for WMF operations. The groundwater monitoring program for the WMF is designed to supplement the engineered and institutional controls by providing additional means of detecting potential contaminant releases from the facility. Because of the close proximity of the WMF to BNL potable supply wells 11 and 12, it is imperative that the engineered and institutional controls implemented at the WMF are effective in ensuring that waste handling operations do not degrade the quality of the soil and groundwater in this area.

4.10.1 WMF Groundwater Monitoring

Well Network

Groundwater quality at the WMF is currently monitored using seven shallow Upper Glacial aquifer wells. Five new downgradient monitoring wells were installed in late 2007 and incorporated into the monitoring program in February 2008. The new wells were positioned downgradient of the buildings based on the current southeast groundwater flow direction. Two wells (055-03 and 055-10) are used to monitor background water quality, and the five newly installed wells monitor groundwater quality downgradient of the three main waste handling and storage facilities. Wells 066-220 and 066-221 are located downgradient of the RCRA Building, wells 066-222 and 066-223 are located downgradient of the Reclamation Building, and well 066-224 is located downgradient of the Mixed Waste Building. The rest of the older wells are being maintained for the collection of water-level data, and the possible future collection of groundwater samples. Locations of the monitoring wells are shown on **Figure 4-26**.

Sampling Frequency and Analysis

During 2009, the WMF wells were sampled in February and August. Groundwater samples were analyzed twice for VOCs, tritium, gamma spectroscopy, gross alpha, and gross beta, and one time for metals and anions (e.g., chlorides, sulfates, and nitrates) (**Table 1-6**). A complete set of monitoring data and groundwater flow maps were provided to the NYSDEC in the *2009 Groundwater Monitoring Report for the Waste Management Facility* (BNL 2010d).

4.10.2 WMF Monitoring Well Results

Radiological Analyses

Gross alpha and beta levels in samples from both upgradient and downgradient monitoring wells were consistent with background concentrations, and no BNL-related, gamma-emitting radionuclides were identified. During the February sample period, tritium was detected in Reclamation Building area well 066-223 at a trace concentration of 440 pCi/L.

Non-Radiological Analyses

The anions (chlorides, sulfates, and nitrates) and most metals concentrations were below applicable NYS AWQS. Sodium was detected at concentrations above the 20 mg/L NYS AWQS in upgradient wells 055-03 and 055-10 at concentrations up to 54.2 mg/L, and in downgradient well 066-221 at a concentration of 48.5 mg/L. The elevated sodium concentrations detected in both upgradient and downgradient wells since 1999 are likely due to nearby road salting operations. No VOCs were detected at concentrations above NYS AWQS.

4.10.3 WMF Groundwater Monitoring Program Evaluation

Groundwater monitoring results for 2009 were consistent with previous years' monitoring, and continued to show that WMF operations are not affecting groundwater quality. There were no outdoor or indoor spills at the facility that could have impacted soil or groundwater quality. Although there continue to be periodic detections of trace levels of tritium in the groundwater, a thorough review of waste management operations suggests that the tritium was not released from the WMF.

4.10.4 WMF Recommendation

For 2010, monitoring will continue as required by the RCRA Part B Permit.

4.11 Building 801

In early December 2001, approximately 8,000 gallons of stormwater seeped into the basement of Building 801. Analysis of the floodwater indicated that the water contained Cs-137 (up to 784 pCi/L), Sr-90 (594 pCi/L), and tritium (25,000 pCi/L). It is believed that the floodwater became contaminated when it came into contact with the basement floor, which contains significant residual contamination from historical radiological spills. When the floodwater was pumped from the basement on March 8, 2002, approximately 4,950 gallons of contaminated water were removed. Taking into account possible losses due to evaporation, estimates were that between 1,350 and 2,750 gallons of contaminated floodwater might have seeped into the soil below Building 801. To evaluate the potential impact of such a release to groundwater quality, BNL installed a new monitoring well immediately downgradient of the building and monitored several nearby wells.

4.11.1 Building 801 Groundwater Monitoring

Well Network

Four downgradient wells are used to evaluate potential impacts to groundwater from the 2001 floodwater event. Well 065-169 is approximately 10 feet south of Building 801, whereas wells 065-37 and 065-170 are approximately 80 feet downgradient of the building (**Figure 3.2.15-1**). These wells were installed in 1999 to monitor historical releases from the Waste Concentration Facility and the former Pile Fan Sump area. Well 065-37 is screened close to the water table, whereas wells 065-169 and 065-170 are screened approximately 10 feet below the water table. In order to monitor groundwater quality at the water table directly downgradient of Building 801, well 065-325 was installed in October 2002.

Sampling Frequency and Analysis

During 2009, Building 801 monitoring well 065-325 was sampled one time under the Facility Monitoring Program (**Table 1-6**). The samples were analyzed for gross alpha, gross beta, gamma-emitting radionuclides (e.g., Cs-137), and tritium. Monitoring wells 065-37, 065-169, and 065-170 were sampled one time under the CERCLA program, and the samples were analyzed for Sr-90 and gamma emitting radionuclides. The sample from well 065-37 was also analyzed for tritium (**Table 1-5**).

4.11.2 Building 801 Monitoring Well Results

During 2009, Sr-90 concentrations in samples collected from shallow groundwater monitoring wells downgradient of Building 801 were consistent with pre-December 2001 values, with a maximum concentration of 52.3 pCi/L detected in well 065-37 (**Figure 4-27**). Although the samples from well 065-325 were not analyzed for Sr-90, the gross beta result (39.8 pCi/L) indicates that the Sr-90 level would have been consistent with past results. No tritium or Cs-137 were detected in either well 065-37 or 065-325. Lower levels of Sr-90 were detected in slightly deeper wells 065-169 and 065-170, with maximum concentrations of 13.9 pCi/L and 1.38 pCi/L, respectively.

4.11.3 Building 801 Groundwater Monitoring Program Evaluation

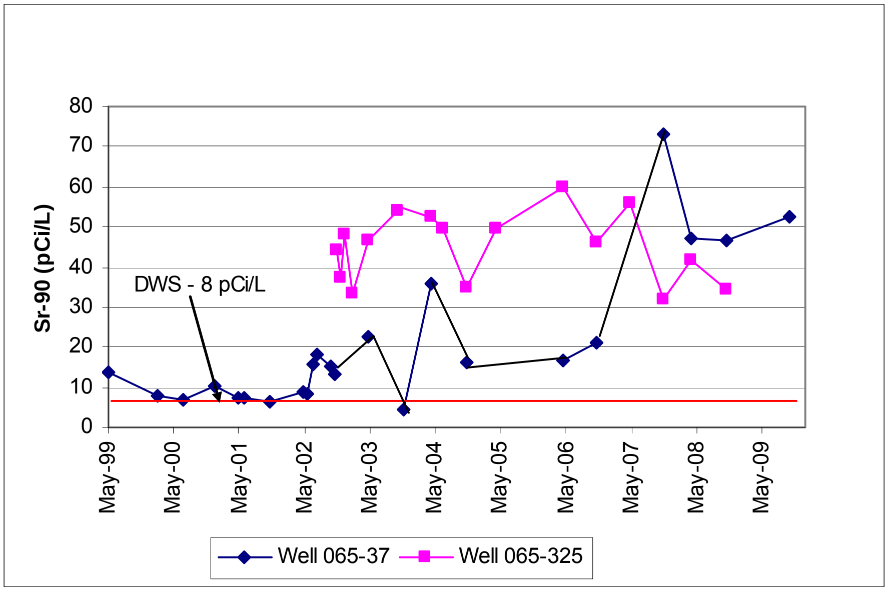
During 2009, Sr-90 concentrations in samples collected from shallow groundwater downgradient of Building 801 were consistent with pre-December 2001 values. Additionally, Cs-137 has not been detected in any of the groundwater samples since the floodwater event. It is estimated that from the December 2001 Building 801 floodwater release, it could take approximately 3 to 8 years for Sr-90 and approximately 100 years for Cs-137 to migrate to the closest downgradient well (065-325). Furthermore, detecting any new groundwater impacts from this release will be difficult to identify, as the local groundwater is already contaminated with radioactivity from legacy releases from Building 801 and/or the nearby former Pile Fan Sump (**Section 3.2.15**).

4.11.4 Building 801 Recommendations

The following is recommended for the Building 801 groundwater monitoring program:

- For 2010, the monitoring frequency for well 065-325 will be decreased from semiannually to annually, whereas the remainder of the wells will continue to be monitored annually.

Figure 4-27.
Building 801
Sr-90 Concentration Trends in Downgradient Wells 065-37 and 065-325.



This page intentionally left blank.

5.0 SUMMARY OF RECOMMENDATIONS

This section is provided as a quick reference to all of the recommendations included in **Sections 3** and **4**. The recommendations are sequenced as they appear in **Sections 3** and **4**. **Table 5-1** summarizes the changes to the monitoring well sampling programs.

5.1 OU I South Boundary Pump and Treat System

The following are recommendations for the OU I South Boundary Pump and Treat System and groundwater monitoring program:

- Install a permanent well approximately 75 feet north of EW-1 and EW-2. Data from this well will be used to determine when the higher concentration segment of the plume has been completely captured.
- Based on data from the new monitoring well (above recommendation), evaluate increasing the operational duration of EW-1 and EW-2 to ensure meeting the cleanup goal for this project.
- Install two new sentinel wells approximately 200 feet south of the Princeton Avenue firebreak road to monitor for the leading edge of the Sr-90 plume.

5.2 Carbon Tetrachloride Pump and Treat System

The following is the recommendation for the OU III Carbon Tetrachloride Groundwater Remediation System and monitoring program:

- Continue monitoring the remaining Groundwater Monitoring wells until MCLs are achieved.

5.3 Building 96 Air Stripping System

The following are recommendations for the OU III Building 96 Groundwater Remediation System and monitoring program:

- Maintain full time operation of treatment well RTW-1.
- Install temporary wells upgradient of recirculation wells RTW-2, RTW-3, and RTW-4. If TVOCs in these wells and the recirculation wells are below 50 µg/L, then wells RTW-2, RTW-3, and RTW-4 will be placed in standby mode. Maintain a monthly sampling frequency of the influent and effluent for each well.
- Maintain integrity of the plastic liner covering the PCE-contaminated soils. Excavate the source area in the summer/fall of 2010. This also involves the removal of monitoring well 085-353 located in the center of the proposed excavation area. Following excavation, three additional monitoring wells will be installed to monitor the effectiveness of the contaminated soil removal, including a replacement for well 085-353.
- Continue to analyze for total chromium and hexavalent chromium in the monitoring wells quarterly, and in the effluent to RTW-1 two times per month.
- Continue to maintain the resin treatment in standby mode, and if concentrations of hexavalent chromium increase to over 50 ug/L in RTW-1, treatment would resume.
- Based on the results of the data from the three temporary wells installed along Weaver Drive, a permanent well will be installed.

5.4 Middle Road Pump and Treat System

The following recommendations are made for the OU III Middle Road Pump and Treat System and groundwater monitoring program:

- Maintain the routine operation and maintenance monitoring frequency that is currently in effect.
- Maintain extraction wells RW-4, and RW-6 in standby mode during 2010. Restart well RW-5 and operate until TVOC concentrations drop below 50 µg/L for two consecutive quarterly extraction well sampling events. Restart the wells if extraction or monitoring well data indicate that TVOC concentrations exceed the 50 µg/L capture goal. Maintain a minimum pumping rate of 250 gpm on well RW-2.
- Install one temporary well approximately 300 feet east of monitoring well 104-36 and based upon the results install a monitoring well to monitor the progression of higher upgradient concentrations of TVOCs to the treatment system.
- Install a monitoring well centered on the high concentrations identified in the recent temporary well near well RW-1.

5.5 OU III South Boundary Pump and Treat System

The following are recommendations for the OU III South Boundary Pump and Treat System and groundwater monitoring program:

- Maintain wells EW-6, EW-7, EW-8, and EW-12 in standby mode. The system's extraction wells will continue to be sampled on a quarterly basis. The wells will be restarted if extraction or monitoring well data indicate TVOC concentrations exceed the 50 µg/L capture goal.
- Maintain the routine operations and maintenance monitoring frequency implemented last year.
- It is recommended that a temporary well be installed near well EW-4 to evaluate how deep the high concentrations of VOCs are near the extraction well. This well should be installed to a depth of approximately -160 feet below MSL, until the Magothy Brown Clay is encountered. This will help evaluate whether the VOCs detected in well 121-43 are caught in the stagnation zone or may be passing under well EW-4.

5.6 Western South Boundary Pump and Treat System

The following are recommendations for the OU III Western South Boundary Treatment System and groundwater monitoring program:

- Continue full-time operation of extraction well WSB-1, and pulse pumping of WSB-2 at the schedule of one month on and two months off. This process will continue and any changes to the VOC concentrations in the influent and the monitoring wells will be evaluated.
- If any of the three bypass detection wells show increasing VOC trends, the need to take further action will be evaluated.
- Due to indications of increased TVOC concentrations in plume core monitoring wells in close proximity to extraction well WSB-1, installation of a permanent monitoring well should be implemented during 2010. The well should be located approximately 700 feet north of WSB-1 to provide a data point between this well and the Middle Road.
- To better define the northerly portion of the core area of the plume where higher concentrations of dichlorodifluoromethane have been detected, two temporary wells should be installed in the vicinity of Princeton Avenue.
- Maintain the routine O&M monitoring frequency that began in 2005.

5.7 Industrial Park In-Well Air Stripping System

The following are recommendations for the Industrial Park In-Well Air Stripping System and groundwater monitoring program:

- The current routine operations and maintenance monitoring frequency will be maintained during 2010. The system will continue operations at 60 gpm per well except for well UVB-1, and UVB-7 which are to remain in a standby mode. It is recommended that well UVB-2 be placed in standby as TVOC concentrations have dropped to below 5 µg/L in this well and all of the monitoring wells in the vicinity are below 50 µg/L TVOC. Monthly recovery well sampling will continue, and if TVOC concentrations greater than 50 µg/L are observed, wells UVB-1, UVB-2 or UVB-7 will be restarted.
- Currently all the monitoring wells except 000-262 are below the capture goal of 50 µg/L. All of the extraction wells now have influent concentrations below the capture goal of 50 µg/L. If concentrations in well 000-262 drop below the TVOC 50 µg/L capture goal a petition to shutdown this system may be submitted to the regulators.
- A temporary well should be installed and sampled between wells UVB-3 and UVB-4 to evaluate the VOC concentrations in this area since no monitoring wells are present in this area.

5.8 Industrial Park East Pump and Treat System

The following is the recommendation for the Industrial Park East Pump and Treat System and groundwater monitoring program:

- Continue the current groundwater monitoring post shutdown monitoring schedule.
- It is recommended that one additional downgradient monitoring well be installed in the vicinity of monitoring well 000-107 on Stratler Drive to monitor Magothy contamination identified in well 000-494.

5.9 North Street Pump and Treat System

The following are recommended for the North Street Pump and Treat System and groundwater monitoring program:

- Maintain the operations and maintenance sampling frequency for monitoring wells.
- Due to historically low VOC concentrations, the sampling frequency for monitoring well 000-476 will be reduced from semiannual to annual.
- Due to the location of well 086-43 north of the Former Landfill (with respect to the plume) and since groundwater samples have not exceeded AWQS since it was installed, it is recommended that this well be dropped from the North Street monitoring program.
- VOCs have remained below AWQS for wells 115-33, 115-34, and 115-35 since they were installed in 1996, and there have been no detections above AWQS for well 115-32 since 2004. Additionally, tritium concentrations have been less than 400 pCi/L in each of these four wells since they were installed. As a result, it is recommended that these four wells be dropped from the North Street monitoring program.
- It is recommended to begin pulse-pumping extraction well NS-1, one month on and one month off during 2010, due to TVOC concentrations below 50 µg/L in upgradient monitoring wells. If

there is any rebounding of higher TVOC concentrations, the extraction well will be placed back in to full-time operation.

5.10 North Street East Pump and Treat System

The following are the recommendations for the North Street East Pump and Treat System and groundwater monitoring program:

- Extraction well NSE-1 will remain in full time operation. Shut off extraction well NSE-2, placing it in a stand-by mode. If concentrations above the capture goal of 50 µg/L TVOCs are observed in either the core monitoring wells or the extraction wells, NSE-2 will be put back into full-time operation.
- Install a temporary well northwest (upgradient) of monitoring well 000-477 to determine the extent of VOC concentrations in this area.
- Drop monitoring well 800-54, located south of Moriches Middle Island Road, from the North Street East sampling program.
- Sample for Tritium only once per year in all wells.
- Following the review of additional monitoring well data, specifically evaluating 000-477, a Petition for Shutdown of the system will be prepared during 2010.
- Continue the shutdown monitoring frequency (sampled quarterly) for the NSE monitoring wells through 2010.

5.11 LIPA/Airport Pump and Treat System

The following are recommendations for the LIPA/Airport Groundwater Pump and Treat System and groundwater monitoring program:

- Continue the airport extraction wells pulse-pumping schedule of pumping one week per month except for wells RTW-1A and RW-6A, which will continue with full-time operations. If concentrations above the capture goal of 10 µg/L TVOCs are observed in any of the extraction wells or the monitoring wells adjacent to them, the well(s) will be put back into full-time operation.
- Maintain LIPA wells EW-1L and EW-3L in standby mode. These extraction wells will be restarted if TVOC concentrations rebound above the 50 µg/L capture goal in either the plume core monitoring wells or the extraction wells.
- Place LIPA Well EW-2 in standby as this well was below AWQS throughout 2009.

5.12 Magothy Monitoring

No changes to the Magothy groundwater monitoring program are warranted at this time.

5.13 Central Monitoring

No changes to the OU III Central groundwater monitoring program are warranted at this time.

5.14 Off-Site Monitoring

No changes to the OU III Off-Site Groundwater Monitoring Program are warranted at this time.

5.15 South Boundary Radionuclide Monitoring Program

The following is the recommendation for the OU III South Boundary Radionuclide groundwater monitoring program:

- Since there are wells directly upgradient of monitoring wells 121-43, 122-24, 122-25, 122-34, and 122-35 and there have been no radionuclide detections reported, sampling of these wells for radionuclides should be discontinued.

5.16 BGRR/WCF Strontium-90 Treatment System

The following are recommendations for the BGRR/WCF groundwater treatment system and monitoring program:

- Implement the installation of four additional extraction wells during 2010 to address the Sr-90 hot spots identified in the WCF plume.
- Install several temporary wells to characterize Sr-90 concentrations in the WCF source area.
- For the BGRR Sr-90 plume, install sentinel wells on the south side of Brookhaven Avenue to monitor the leading edge of the plume.
- Characterize the width of the plume at the well 075-664 location and install a new permanent monitoring well for the BGRR Sr-90 plume adjacent to monitoring well 075-664 screened at a shallower depth.
- Install temporary wells at Brookhaven Avenue to characterize the leading edge of the Pile-Fan Sump plume.

5.17 Chemical/Animal Holes Strontium-90 Treatment System

The following are the recommendations for the Chemical/Animal Holes Strontium-90 Treatment System and groundwater monitoring program:

- Continue to operate extraction wells EW-1, EW-2 and EW-3 in full time mode.
- Maintain the operations and maintenance phase monitoring well sampling frequency begun in 2009.
- Drop wells 106-24, 106-25 and 114-01 from the monitoring program since there have been no historical detections of Sr-90 in this well.
- Complete temporary well investigations in the vicinity of monitoring well 106-48 to determine the current plume perimeter.

5.18 HFBR Tritium Pump and Recharge System

The following are recommendations for the HFBR AOC 29 Tritium Pump and Recharge System and monitoring program:

- Increase the sampling frequency for monitoring wells 075-42, 075-43, 075-44, and 075-45 to monthly as a result of the historical high water-table elevations during 2010 to monitor for any corresponding source area tritium releases. Continue monitoring for six months and then re-evaluate based on water-table conditions and observed tritium data.

- Continue to install and sample temporary wells as necessary to characterize the location of the high tritium concentration area approaching EW-16. Results will be communicated to the regulators via the IAG conference call and quarterly/annual reports.
- Continue operating EW-16 and EW-11 in 2010. Monitor tritium concentrations in EW-16 on a weekly basis.
- The pump and recharge well(s) will be operated until the tritium concentrations from Weaver Drive to EW-16 drop below 20,000 pCi/L. The estimated operational duration of 2 to 4 years (2011 to 2013) is based on the length of the high concentration area slug and the time it would take to be completely captured by EW-16. The decision to turn the wells back to standby will be based on:
    - concentrations of tritium decreasing to less than 20,000 pCi/L in the monitoring wells at Weaver Drive as well as the extraction wells, and
    - verification that EW-16 has captured concentrations of tritium greater than 20,000 pCi/L in this area. A decision to turn the wells back to standby will be supported with data from additional permanent and temporary wells, as needed.

5.19 OU IV AS/SVE System Post Closure Monitoring Program

The following is the recommendation for the OU IV AS/SVE Post Closure Monitoring program:

- Due to the increasing concentrations of cis-1,2-dichloroethylene and tetrachloroethylene, the sampling frequency of monitoring well 076-185 should increase to semi-annual.

5.20 Building 650 (Sump Outfall) Strontium-90 Monitoring

The following recommendations are made for the Building 650 Strontium-90 Groundwater Monitoring Program:

- Drop monitoring wells 066-17, 076-167, 076-20, 076-26, and 076-183 from the monitoring program. The sampling frequency is currently annual in these wells. This recommendation is based on both the long history of very low Sr-90 detections in these wells along with the fact that they are clearly outside of the Sr-90 plume area based on the latest comprehensive plume characterization. The sampling of wells can be resumed and sampling frequencies increased if warranted by future changes in groundwater flow conditions.
- Re-instate an annual sampling frequency for well 076-182 in light of the latest plume characterization as it appears to be positioned as a sentinel well for the leading edge of the plume.
- Update the groundwater model with the 2009/2010 characterization data and run a new simulation to predict the expected time frame for achieving drinking water standards by natural attenuation of the plume.
- Install two monitoring wells in the downgradient plume core area and a sentinel well near the leading edge of the plume.

5.21 Operable Unit V

The following recommendations are made for the OU V plume groundwater monitoring program:

- It appears that the OU V VOC plume has largely attenuated. No individual VOC exceeded the NYS AWQS in 2008 or 2009. It was recommended in the *2008 BNL Groundwater Status Report* that the monitoring well network be sampled on an annual basis for one more year. If individual VOC concentrations and tritium remained below NYS AWQS during 2009, BNL could recommend reducing the number of wells being monitored. It is recommended that monitoring for VOCs and tritium be discontinued based on the observation that there have been no detections of either constituent above NYS AWQS dating back to 1997 and 1998 (the timeframe in which these wells were installed) in the following wells: 037-02, 037-04, 041-01, 041-02, 041-03, 049-05, 050-02, 061-03, 061-04, 000-123, 000-147, 000-141, 000-142, 000-143, 000-144, 000-145, 000-146, 600-15, 600-16, 600-18.
- There have been no detections of percholorate in wells 000-122, 000-123, and 049-06 since sampling began in 2004. Based on the absence of perchlorate in these wells over the previous six years analysis for perchlorate will be discontinued. Continue perchlorate sampling in the five remaining monitoring wells for one more year. If perchlorate concentrations are below standards for two consecutive years, sampling for perchlorate will be discontinued.
- If individual VOCs remain below NYS AWQS in monitoring wells during 2010 a petition will be prepared and submitted to the regulatory agencies to conclude the monitoring program.

5.22 Operable Unit VI EDB Pump and Treat System

The following recommendations are made for the OU VI EDB Pump and Treat System and groundwater monitoring program:

- Maintain routine operations of the treatment system.
- Change the sampling frequency of the extraction wells from monthly to quarterly.

5.23 Site Background Monitoring

No changes to the monitoring program are warranted at this time.

5.24 Current Landfill Groundwater Monitoring

No changes to the Current Landfill groundwater monitoring program are warranted at this time.

5.25 Former Landfill Groundwater Monitoring

No changes to the Former Landfill groundwater monitoring program are warranted at this time.

5.26 Alternating Gradient Synchrotron (AGS) Complex

The following recommendations are made for the AGS Complex groundwater monitoring programs:

- The monitoring frequency for the Booster area, NSRL, E-20 Catcher, Building 914, g-2 Beam Stop, J-10 Beam Stop, and former U-Line area monitoring wells will continue to be annually.
- The Building 912 wells used to track the g-2 tritium plume will continue to be sampled semiannually, whereas the remainder of the Building 912 monitoring wells will continue to be sampled annually.

5.27 g-2 Tritium Source Area and Groundwater Plume

As required by the ROD, BNL will continue to conduct routine inspections of the g-2 cap, and to monitor groundwater quality downgradient of this facility. The downgradient sections of the g-2 plume will be monitored until tritium concentrations drop below the 20,000 pCi/L DWS. The following are recommended for the g-2 groundwater monitoring program:

- The source area monitoring wells will continue to be sampled quarterly for tritium and annually for sodium-22, and the downgradient sections of the tritium plume will continue to be monitored using a combination of permanent and temporary wells.
- During the spring of 2010, additional temporary wells will be installed along Transect F to verify the western margin of the g-2 tritium plume and establish new Transect G. During the fall of 2010, additional temporary wells will be installed along Transects D, E, F and G to track the g-2 plume and evaluate its attenuation in the aquifer.
- Re-run the groundwater model for the downgradient portion of the plume using 2010 monitoring data.

5.28 Brookhaven Linac Isotope Producer Facility

As required by the ROD, BNL will continue to conduct routine inspections of the BLIP cap, and to monitor groundwater quality downgradient of the facility. The following is recommended for the BLIP groundwater monitoring program:

- Because tritium levels in groundwater have been continuously below the 20,000 pCi/L DWS since January 2006, the monitoring frequency for the downgradient monitoring wells 064-47, 064-48, and 064-67 will continue to be semiannually.
- Sampling frequency for the two upgradient (054-61 and 064-46) and two downgradient wells (064-49 and 064-50) will continue to be annually.

5.29 Relativistic Heavy Ion Collider Facility

No changes to the Relativistic Heavy Ion Collider Facility groundwater monitoring program are warranted at this time.

5.30 Brookhaven Medical Research Reactor Facility

The following is recommended for the BMRR groundwater monitoring program:

- The monitoring frequency for the BMRR wells will continue to be once every two years, with the next set of samples being collected in 2010.

5.31 Sewage Treatment Plant

No changes to the STP groundwater monitoring program are warranted at this time.

5.32 Motor Pool Maintenance Area

No changes to the Motor Pool groundwater monitoring program are warranted at this time.

5.33 On-Site Service Station

No changes to the On-Site Service Station groundwater monitoring program are warranted at this time.

5.34 Major Petroleum Facility Area

No changes to the Major Petroleum Facility Area groundwater monitoring program are warranted at this time.

5.35 Waste Management Facility

No changes to the Waste Management Facility groundwater monitoring program are warranted at this time.

5.36 Building 801

The following is recommended for the Building 801 groundwater monitoring program:

- For 2010, the monitoring frequency for well 065-325 will be decreased from semiannually to annually, whereas the remainder of the wells will continue to be monitored annually.

This page intentionally left blank.

Reference List

Arcadis Geraghty & Miller. 2003. *Final Magothy Aquifer Characterization Report*. Brookhaven National Laboratory, Upton, NY. May 2003.

Aronson, D.A., and Seaburn, G.E. 1974. *Appraisal of the operating efficiency of recharge basins on Long Island, NY in 1969.* USGS Supply Paper 2001-D.

BNL. 2000a. *Carbon Tetrachloride Groundwater Removal Action Operations and Maintenance Manual.* Brookhaven National Laboratory, Upton, NY. January 26, 2000.

BNL. 2000b. *Operations and Maintenance Manual for the OU III Offsite Removal Action.* Brookhaven National Laboratory, Upton, NY. February 11, 2000.

BNL. 2001a. *BNL Spill Prevention, Control and Countermeasures Plan*. Brookhaven National Laboratory, Upton, NY.

BNL. 2001b. *OU IV Remediation Area 1 Proposed Supplemental Remedial Effort - Work Plan,* Brookhaven National Laboratory, Upton, NY, May 2001.

BNL. 2002a. *Building 96 Groundwater Source Control Treatment System Operations and Maintenance Manual*. Brookhaven National Laboratory, Upton, NY. April 2002.

BNL. 2002b. *Operations and Maintenance Manual for the Western South Boundary Treatment System*. Brookhaven National Laboratory, Upton, NY. December 2002.

BNL. 2002c. *Petition For Closure and Termination of Formal Post Closure Monitoring of OU IV Air Sparge/Soil Vapor Extraction Remediation System,* Brookhaven National Laboratory, Upton, NY, June 2002.

BNL. 2003a. *Operations and Maintenance Manual for the OU III Middle Road and South Boundary Groundwater Treatment Systems, Revision 1*. Brookhaven National Laboratory, Upton, NY. July 18, 2003.

BNL. 2003b. *Final CERCLA Five Year Review Report for OU IV*. Brookhaven National Laboratory, Upton, NY.

BNL. 2004a. *Petition to Shutdown the OU III Carbon Tetrachloride Treatment System*. Brookhaven National Laboratory, Upton, NY. April 2004.

BNL. 2004b. *OU III Building 96 Operations and Maintenance Manual Modification*. Brookhaven National Laboratory, Upton, NY. June 2004.

BNL. 2004c. *Operations and Maintenance Manual for the Industrial Park East Offsite Groundwater Remediation System*. Brookhaven National Laboratory, Upton, NY. September 3, 2004.

BNL. 2004d. *Operations and Maintenance Manual for the North Street/North Street East Offsite Groundwater Treatment Systems*. Brookhaven National Laboratory, Upton, NY. August 24, 2004.

BNL 2004e. *Operations and Maintenance Manual for the OU IV EDB Groundwater Treatment System*. Brookhaven National Laboratory, Upton, NY. Sept. 16, 2004.

BNL 2005a. *OU III Explanation of Significant Differences*. Brookhaven National Laboratory, Upton, NY.

BNL. 2005b. *Operations and Maintenance Manual for the RA V Treatment Facility*. Brookhaven National Laboratory, Upton, NY. October 7, 2005.

BNL. 2005c. *2004 BNL Groundwater Status Report.* Brookhaven National Laboratory, Upton, NY. June 2004.

BNL 2005d. *Operations and Maintenance Manual for the Sr-90 BGRR/WCF/PFS Groundwater Treatment System.* Brookhaven National Laboratory, Upton, NY.

BNL. 2007a. *BNL Land Use Controls Management Plan*, Revision 2. BNL, July 25, 2007.

BNL 2007b. *Record of Decision for Area of Concern 16T g-2 Tritium Source Area and Groundwater Plume, Area of Concern 16K Brookhaven Linac Isotope Producer, and Area of Concern 12 Former Underground Storage Tanks.* Brookhaven National Laboratory, Upton, NY. May 10, 2007.

BNL. 2008a. BNL *2006 Environmental Monitoring Plan,* Brookhaven National Laboratory, Upton, NY. January 2008

BNL. 2008b. *2007 BNL Groundwater Status Report.* Brookhaven National Laboratory, Upton, NY. June 2008.

BNL. 2008c. Operations and Maintenance Manual for the LIPA/Airport Groundwater Treatment System, Revision 2. Brookhaven National Laboratory, Upton, NY. November 2008.

BNL. 2008d. *Chemical/Animal Holes Strontium-90 Groundwater Treatment System Operations and Maintenance Manual*. Brookhaven National Laboratory, Upton, NY. November 2008.

BNL. 2009a. *Final Report for Building 96 Recommendation for Source Area Remediation.* Brookhaven National Laboratory, Upton, NY, March 2009.

BNL. 2009b. *Operations and Maintenance Plan for the High Flux Beam Reactor Tritium Plume Pump and Recharge System.* Brookhaven National Laboratory, Upton, NY, February 2009.

BNL. 2009c. *2008 Groundwater Monitoring Report for the Waste Management Facility,* Brookhaven National Laboratory, Upton, NY.

BNL 2009d. 2008 *BNL Groundwater Status Report, SER Volume II*, Brookhaven National Laboratory, Upton, NY June 2009

BNL. 2010. *2009 Environmental Monitoring Report, Current and Former Landfill Areas.* Brookhaven National Laboratory, Upton, NY, March 2010.

deLaguna, W. 1963. *Geology of Brookhaven National Laboratory and Vicinity, Suffolk County, New York.*

DOE. 1993**.** *Order 5400.5, Radiation Protection of the Public and the Environment***.** January 1993.

DOE. 2003. *Order 450.1, Environmental Protection Program*, 2003.

Franke, O.L. and McClymonds, P. 1972. *Summary of the hydrologic situation on Long Island, NY, as a guide to water management alternatives*. USGS Professional Paper 627-F.

Holzmacher. 2004. *LIPA/Airport Pump Test Report.*

Paquette, D.E.; Bennett, D.B, and Dorsch, W.R. 2002. *Brookhaven National Laboratory Groundwater Protection Management Description.* BNL Report 52664. May 31, 2002.

Scorca, M.P., W.R. Dorsch, and D.E. Paquette. 1999. *Stratigraphy and Hydrologic Conditions at the Brookhaven National Laboratory and Vicinity, Suffolk County, NY, 1994-97*. U.S. Geological Survey Water Resources Investigations Report 99-4086.

U.S. Environmental Protection Agency (EPA). 1992. Interagency Agreement, Administrative Docket Number: II-CERCLA-FFA-00201, May 1992.