BROOKHAVEN NATIONAL LABORATORY

2007 SITE ENVIRONMENTAL REPORT

Volume II

GROUNDWATER STATUS REPORT

2007
SITE ENVIRONMENTAL REPORT
VOLUME II
GROUNDWATER STATUS REPORT

June 13, 2008
Revised - September 8, 2008

Environmental and Waste Management Services Division
Long Term Response Actions 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 *2007 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 and Waste Management Services

John Burke	William Dorsch	Brian Foley
George Goode	Robert Howe	Richard Lagattolla
Chris Ogeka	Doug Paquette	Vincent Racaniello
Kathleen Robinson	Andrew Rohkohl	Frank Tramontano
Susan Young		

Environmental Restoration Projects
Les Hill

Plant Engineering Division
Eric Kramer

J.R. Holzmacher P.E., LLC

Yuping Shen	Patricia Zalak	Tony Zalak

R&C Formations, LTD.

Robert Casson	Robert Heiss Jr.	Philip Hoffken Jr.
Melissa Carpentieri		

P.E. Consulting Engineer
Drew Bennett

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Contents

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List of Appendices

List of Figures

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List of Tables

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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
ASL	Analytical Services Laboratory
ASTM	American Society for Testing and Materials
AWQS	Ambient Water Quality Standards
BERA	Brookhaven Employees Recreation Association
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
CFR	Code of Federal Regulations
COC	Chain of Custody
CR	chromium
CRDL	Contract Required Detection Limit
CSF	Central Steam Facility
CY	calendar year
DCA	1,1-dichloroethane
DCE	1,1-dichloroethene
DCG	Derived Concentration Guide
DMR	Discharge Monitoring Report
DOE	U.S. Department of Energy
DQO	Data Quality Objective
DTW	Depth to Water
DWS	Drinking Water Standard
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
ER	Environmental Restoration
ERP	Emissions Rate Potential
ES	Environmental Surveillance
ESD	Explanation of Significant Differences
EW	extraction well
EWMSD	Environmental and Waste Management Services Division
FFA	Federal Facility Agreement
FRP	Facility Response Plan
FFS	Focused Feasibility Study
FS	Feasibility Study
ft msl	feet above mean sea level
GAC	granular activated carbon
gal/hr	gallons per hour
GeV	giga electron volt
GPM	gallons per minute
HFBR	High Flux Beam Reactor
HWMF	Hazardous Waste Management Facility
IAG	Inter Agency Agreement
ID	identification
K gal	thousand gallons
lb/gal	pounds per gallon
lbs	pounds
LEL	Lower Explosive Limit
LIE	Long Island Expressway
LINAC	Linear Accelerator
LIPA	Long Island Power Authority
LOAEL	Lowest Observed Adverse Effects Level
LTRA	Long Term Response Actions
MCL	Maximum Contaminant Level
MDL	Minimum Detection Limit
mg/L	milligrams per liter
MGD	millions of gallons per day
MNA	Monitored Natural Attenuation
MPF	Major Petroleum Facility
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

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	pico Curies per liter
PE	Plant Engineering
PLC	programmable logic controller
ppb	parts per billion
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
SCGs	Standards, Criteria and Guidances
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	semi-volatile organic compound
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
WMF	Waste Management Facility

2007 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** – restoring groundwater quality that BNL has impacted
- **Communication** – communicating the findings and the results of the program to regulators and other stakeholders

The *2007 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 twelfth annual groundwater status report issued by BNL. This document examines the performance of the program on a project-by-project basis, as well as comprehensively in a "watershed-like" analysis.

How to Use This Document. This detailed technical document includes summaries of laboratory data, as well as data interpretations. It is intended for internal BNL users, regulators, and other technically oriented stakeholders. Less technical summaries of this information are presented as Chapter 7 of this Site Environmental Report. Environmental Restoration (ER) refers to work being performed under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) by the Long Term Response Actions (LTRA) Group, including measuring and monitoring of groundwater remediation performance, and efforts in achieving cleanup goals. Environmental Surveillance (ES) refers to the monitoring of groundwater quality at active research and support facilities, primarily in response to Department of Energy (DOE) Order 450.1, 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 Interagency Agreement (IAG) 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 drivers of the data collection work in 2007, 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 2007. Section 3 summarizes the groundwater cleanup data, progress towards achieving the site's cleanup goal, and recommended modifications to the remediation systems or monitoring programs. Section 4 summarizes the groundwater surveillance 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 2007:

- The desired flow conditions continued to be maintained in the central portion of the site during 2007 with 90 percent of the total site wide potable and process 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 2007.
- The implementation of effective water conservation measures has resulted in a significant reduction in the amount of process and supply water pumped from the aquifer since 1999.
- Total annual precipitation in 2007 was 45.3 inches, which is below the yearly average of 48 inches. Seven of the past 10 years have featured above normal average precipitation at BNL.

GROUNDWATER RESTORATION PROGRESS AND ISSUES (CERCLA)

Table E-1 summarizes the status and progress of groundwater cleanup at BNL under the provisions of CERCLA. During 2007, twelve VOC groundwater remediation systems were in operation, along with two Sr-90 treatment systems. In 2007, 198 pounds of volatile organic compounds (VOCs) were removed from the aquifers by the treatment systems. To date, 5,897 pounds of VOCs in the aquifer have been removed. The Operable Unit (OU) III Chemical Holes Strontium-90 System removed 0.27 mCi of strontium-90 (Sr-90) from the Upper Glacial aquifer in 2007, for a total to date of 2.59 mCi. The OU III BGRR Sr-90 system removed 4.9 mCi of Sr-90 during the year, for a total of 14.15 mCi since operations began in 2005.

Groundwater remediation is expected to be a long-term process for most of the plumes. Noticeable improvements in groundwater quality are evident in the OU I South Boundary, OU III Carbon Tetrachloride, OU III North Street, OU III Industrial Park, OU III LIPA, and OU III South Boundary areas. One system (OU IV AS/SVE) has been decommissioned in 2003, one system remained in standby since 2004 (OU III Carbon Tetrachloride) and a number of individual system extraction wells have been placed on standby. The HFBR Pump and Recharge system was restarted in response to the triggering of the OU III ROD contingency. 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 MCL of 8 pCi/L for Sr-90 at the BGRR in Upper Glacial aquifer by 2070
- Achieve MCL of 8 pCi/L for Sr-90 at the Chemical 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 2007 are summarized in Figures E-1 and E-2, respectively. Significant items of interest during 2007 were the following:

- 725 monitoring wells were sampled as part of the LTRA Groundwater Monitoring Program in 2007, comprising a total of 2,049 groundwater sampling events. Approximately 52 temporary wells were also installed in 2007, for approximately 542 samples. BNL continued to make significant progress in characterizing and restoring groundwater quality at the site.
- During 2007, 1.4 billion gallons of groundwater were treated. (**Table E-1**).

Table E-1.
BNL Groundwater Remediation System Treatment Summary for 1997 – 2007.

	1997 – 2006		2007	
VOCs Remediation (start date)	Water Treated (gallons)	VOCs Removed (pounds)(c)	Water Treated (gallons)	VOCs Removed (pounds)(c)
OU III South Boundary (June 1997)	3,048,952,850	2,537	136,000,000	32
OU III Industrial Park (Sept. 1999)	1,234,478,330	967	130,000,000	43
OU III W. South Boundary (Sept. 2002)	531,647,000	45	71,000,000	4
OU III Carbon Tetrachloride (Oct. 1999)	153,538,075	349	Standby	0
OU I South Boundary (Dec. 1996)	3,047,314,000	331	137,000,000	6
OU III HFBR Tritium Plume (May 1997) (a)	241,528,000	180	7,450,000	0
OU IV AS/SVE (Nov. 1997) (b)	0	35	Decommissioned	0
OU III Building 96 (Feb. 2001)	135,497,416	71	2,800,000	<1
OU III Middle Road (Oct. 2001)	1,139,411,550	707	128,000,000	34
OU III Industrial Park East (May 2004)	226,172,000	29	61,000,000	4
OU III North Street (June 2004)	503,122,000	232	186,000,000	36
OU III North Street East (June 2004)	357,976,000	16	71,000,000	4
OU III LIPA/Airport (June 2004)	675,887,000	200	171,000,000	35
OU VI EDB (August 2004)	333,711,000	NA(d)	138,000,000	NA (d)
Totals	11,616,851,220	5,699	1,239,250,000	198
	2003 – 2006		2007	
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)	10,004,826	2.32	2,400,000	0.27
OU III BGRR (June 2005)	14,551,000	9.25	7,600,000	4.9
Totals	24,555,826	11.57	10,000,000	5.17

Notes:

(a) System was placed in standby mode on Sept. 29, 2000, but restarted 12/07.
(b) Air Sparging/Soil Vapor Extraction system performance measured by pounds of VOC removed. System was dismantled in December 2003.
(c) Values rounded to the nearest whole number.
(d) EDB has been detected at trace levels in the system influent since operations began and well below the standard. Therefore, no removal of VOCs are reported.

- The HFBR Pump and Recharge system was re-started in December 2007 as per the OU III ROD contingency that was triggered in November, 2006. New extraction well EW-16 was constructed several hundred feet north of Princeton Avenue and is operated in conjunction with EW-11. The system is expected to remain on several years until the high concentration tritium slug detected in 2006 has been completely addressed.
- An engineering evaluation for the persistent Building 96 source area PCE looked at various alternatives such as soil excavation, an additional extraction well, soil mixing with vapor extraction, electrical resistance heating, and injection by hydrogen release compounds. Additional characterization to better define the extent of the silt layers and the continuing PCE source associated with these silt layers will be needed prior to the selection of an alternative. Extraction well RTW-2 (which was on standby) was placed back in service in October 2007 due to increasing PCE concentrations in nearby monitoring wells. A design modification along with a SPDES Discharge application was submitted to NYSDEC in February 2008 for converting extraction well RTW-1 to a pumping well discharging to the nearby storm water drainage culvert. Sampling of RTW-1 for as part of the SPDES application detected chromium (VI) concentrations exceeding the DWS. The operation of RTW-1 maintains hydraulic control of the source area. Ion-exchange treatment has been added to this well.
- Two additional extraction wells and five monitoring wells were installed and added to the Chemical Holes Sr-90 system in 2007. The additional extraction wells were necessary to meet the cleanup goal of reducing Sr-90 to below DWS in this plume by 2040.
- Airport System extraction well RTW-6A was installed and placed in operation in November 2007 to address the increasing concentrations in western perimeter monitoring well 800-96 during 2006. This extraction well was necessary to capture and treat the western portion of the plume in this area.
- Sr-90 samples obtained during the 2007 g-2 tritium plume characterization effort identified higher than expected Sr-90 in the vicinity of the HFBR. This is the downgradient portion of the Waste Concentration Facility Sr-90 plume. Based on preliminary groundwater modeling, using the updated plume concentrations, it was determined that several additional extraction wells will be necessary in order to achieve the OU III ESD cleanup goal of 8 pCi/L of Sr-90 by 2070.

Other progress highlights include:

- The OU I South Boundary system resumed full-time operations following a period of pulse pumping, which began in September 2005. This is in anticipation of a higher concentration slug of VOCs in the vicinity of monitoring well 107-40, approaching the south boundary.
- The OU III Carbon Tetrachloride system remained on standby as per the petition for shutdown. There has been no rebound observed in monitoring well carbon tetrachloride concentrations.
- OU III Middle Road extraction wells RW-4, RW-5, and RW-6 remained on standby due to low VOC concentrations.
- OU III South Boundary extraction wells EW-6, EW-7, EW-8, and EW-12 were all on standby due to low VOC concentrations. The highest concentrations at the OU III South Boundary are now limited to the western portion of the system.
- The OU III Western South Boundary system continued pulse pumping operations, which began in September 2005, due to low VOC concentrations.
- OU III Industrial Park extraction well UVB-4 was placed on standby mode in 2007. The system continued to effectively remove VOCs from the Upper Glacial aquifer.

Progress of the groundwater restoration program is summarized in Table E-2.

INSTITUTIONAL CONTROLS

Institutional controls are in place at BNL to ensure effectiveness of all groundwater remedies. During 2007, the institutional controls continue to be effective in protecting human health and the environment. In accordance with the *BNL Land Use Controls Management Plan*, Revision 2 dated July 25, 2007, 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
- 5-year reviews, as required by CERCLA, until cleanup goals are met and to determine the effectiveness of the groundwater monitoring program
- Controls on the installation of new supply wells and recharge basins on BNL property
- Public water service in plume areas south and east of BNL
- Prohibitions on the installation of new potable water supply wells where public water service exists (Suffolk County Sanitary Code Article 4)
- Property access agreements for treatment systems off the BNL property.

An annual update on Institutional Controls summarizes noteworthy issues, changes, breaches etc. was submitted to the regulatory agencies in December 2007.

ENVIRONMENTAL SURVEILLANCE (FACILITY) MONITORING RESULTS

During 2007, the Environmental Surveillance (ES) Program monitored groundwater quality at 10 active research and support facilities. Groundwater samples were collected from 125 wells during 240 individual sampling events. Although no new impacts to groundwater quality were discovered during 2007, 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 Upton Service Station. At the Brookhaven Linac Isotope Producer (BLIP), tritium levels were less than the 20,000 pCi/L DWS during all of 2007.

Following the concurrence from the NYSDEC, a Record of Decision (ROD) was signed by the U.S. DOE and U.S. EPA in early 2007 (BNL 2007b). This ROD requires continued routine inspection and maintenance of the impermeable caps at the g-2 and BLIP source areas, and groundwater monitoring of the source areas to verify the continued effectiveness of the storm water controls. Furthermore, the ROD requires monitoring the g-2 tritium plume until it attenuates to less than the 20,000 pCi/L DWS. Contingency actions have been developed if tritium levels exceeding 1,000,000 pCi/L are detected within the g-2 plume, or if the g-2 tritium plume does not attenuate as predicted by the groundwater model.

Highlights for the surveillance monitoring program are as follows:

- Tritium continues to be detected in the g-2 source area monitoring wells, at concentrations above the 20,000 pCi/L DWS. During 2007 the maximum tritium concentration in source area wells was 94,900 pCi/L in January. Tritium concentrations were less than 50,000 pCi/L during the second half of the year. A short-term spike in tritium levels was observed in January 2008, with a tritium concentration of 186,000 pCi/L detected in source area well 054-07. Tritium levels in this well dropped to 21,800 pCi/L by February 2008. Although the engineered stormwater controls are effectively protecting the activated soil shielding at the source area, monitoring data indicates that the continued release of tritium appears to be related to the flushing of residual tritium from the vadose zone following significant natural periodic fluctuations in the local water table.

- During mid 2007 through early 2008, 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 was 198,000 pCi/L, observed in temporary well GP-73 located approximately 250 feet northwest of the HFBR. The plume was tracked to the area immediately south of the HFBR, with a maximum tritium concentration of 83,000 pCi/L in temporary well GP-84. As a result of natural radioactive decay and dispersion in the aquifer, the tritium plume (as defined by concentrations >20,000 pCi/L MCL) appears to be breaking up into discrete segments.
- Since April 2006, all tritium concentrations in the BLIP facility surveillance wells have been less than the 20,000 pCi/L DWS. The maximum tritium concentration during 2007 was 13,100 pCi/L. During the first half of 2008, tritium concentrations were less than 2,000 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.
- At the Service Station, VOCs associated with petroleum products and solvents continue to be detected in several monitoring wells directly downgradient of the station at concentrations that exceed the DWS. During 2007, high levels of VOCs were detected during the October sample round, with total xylenes detected at 140 μg/L, ethylbenzene at 15 μg/L, 1,2,4-trimethylbenzene at 35 μg/L, and the solvent PCE at a concentration of 14 μg/L. No floating petroleum was detected in the monitoring wells. Monitoring of the leak detection systems at the Service Station indicates that the gasoline storage tanks and associated distribution lines are not leaking. Furthermore, evaluation of current vehicle maintenance operations indicates that all waste oils and used solvents are being properly stored and recycled. Therefore, it is believed that the contaminants detected in groundwater originates from historical vehicle maintenance activities and are not related to current operations.

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 and cleanup programs. A summary of those significant changes follows (specific details of which are provided in Chapter 5):

- **OU I South Boundary System** – Install a temporary well approximately 500 feet north of well 107-40 to characterize the VOC concentrations along the plume center line in this area. Follow up with a permanent monitoring well based on temporary well results. Reduce Sr-90 and tritium sampling frequency for select wells.
- **Carbon Tetrachloride System** – Install several temporary wells along the plume center line upgradient of EW-15. Update the groundwater model and evaluate if the current carbon tetrachloride levels would naturally attenuate to cleanup objectives. Petition for project closure if warranted.
- **Building 96** – Begin operation of the modified RTW-1 as a pumping well with chromium treatment and discharge to the surface water drainage culvert. Install additional soil borings and collect samples as necessary to precisely define the extent of silt layers and PCE soil contamination in the source area. This delineation will assist in the selection of the appropriate remedial alternative for the source area.

- **Middle Road System**– Install a temporary well to confirm the western edge of the plume. Install a temporary well several hundred feet upgradient of RW-1 and locate a permanent well to monitor the plume core.
- **OU III Western South Boundary**– Place extraction well WSB-1 back in full-time operation due to increasing concentrations in plume core monitoring well 126-11.
- **Industrial Park System** – Place extraction well UVB-4 back in operation to address VOCs currently being observed in plume core monitoring well 000-262.
- **Industrial Park East** – Continue pulse pumping for one year, and if no VOC concentration rebound is observed in either the monitoring or extraction wells petition for shutdown of this system.
- **North Street East**– Continue pulse pumping for one year, and if no VOC concentration rebound is observed in either the monitoring or extraction wells petition for shutdown of this system.
- **LIPA/Airport System** – Return extraction well RTW-3A to full-time operations to intercept VOCs migrating from upgradient plume core monitoring wells. Install a temporary well to the west of RTW-3A to locate a perimeter monitoring well in this area.
- **BGRR/Waste Concentration Facility Sr-90 –** Utilize temporary wells to characterize the high concentration Sr-90 slug in the vicinity of the HFBR during the fourth quarter of 2008. Coordinate with g-2 plume tritium characterization to identify the higher tritium concentrations in this area. This data will be used to locate additional extraction wells.
- **Chemical Holes Sr-90** – Implement pulse pumping of EW-1 to evaluate Sr-90 rebounding in this well. Install temporary wells upgradient of plume core well 106-16 to identify the source of increasing Sr-90 detections in this monitoring well.
- **Operable Unit VI System**– Add a plume bypass well east of 000-508 to verify the capture zone of EW-2E.
- **Waste Management Facility** - The five new downgradient groundwater monitoring wells installed at the WMF in late 2007 will be incorporated into the monitoring program starting in February 2008.

Table E-2.
Groundwater Restoration Progress.

Project	Target	Mode	Treatment Type	Treatment Progress	Years of Operation	Highlights
OU I						
OU I South Boundary (RA V)	VOCs	Operational (pulse)	P&T with AS	337 lb of VOCs treated to date	10 of 14	Hot spot migrating toward the extraction wells based on monitoring well data.
Current Landfill	VOCs tritium	Long Term Monitoring & Maintenance	Landfill capping	Cap is maintained and stable	12 of 30	Groundwater quality slowly improving. VOCs and tritium stable or slightly decreasing.
Former Landfill	VOCs Sr-90 tritium	Long Term Monitoring & Maintenance	Landfill capping	Cap is maintained and stable.	11 of 30	Continued decline in Sr-90. VOCs have been below NYS AWQS since 1998.
Former HWMF	Sr-90	Long Term Response Action	Monitoring	NA	NA	Sr-90 detected at 13 pCi/L in well 088-26 in 2007, down from 21.6 in 2003.
OU III						
Chemical/Animal Holes	Sr-90	Operational	P&T with ion exchange (IE)	2.6 mCi Sr-90 removed to date	5 of 10	Installed two new extraction wells in 2007 to meet cleanup goals.
Carbon Tetrachloride source control	VOCs (carbon tetra-chloride)	Standby	P&T with carbon	349 lb of VOCs treated to date	Complete	No rebound of VOCs observed in monitoring wells during 2007.
Building 96 source control	VOCs	RTW-1,3,4 in standby	Recirculation wells with AS	71 lbs of VOCs treated to date	5	Treatment well RTW-2 restarted October 2007 due to rebounding VOC concentrations. Evaluating alternative remedies to address persistent PCE in source area. Cr(VI) detections in RTW-1 will be treated with ion-exchange.
South Boundary	VOCs	Operational (EW-6, EW-7, EW-8 and EW-12 on standby)	P&T with AS	2,569 lbs of VOCs treated to date	10 of 13	Continued decline in monitoring well VOC concentrations at the site boundary with the exception of several wells in the vicinity of EW-4 and EW-5. Determined that VOCs are not migrating below the gray-brown Magothy clay in between the Middle Road and South Boundary.
Middle Road	VOCs	Operational (RW-4, RW-5, and RW-6 on standby)	P&T with AS	784 lbs of VOCs treated to date	6 of 25	Extraction wells RW-1 and -2 continue to show moderate VOC levels. Eastern extraction wells showing low VOC concentrations.

continued

Table E-2 *(continued)***.**
Groundwater Restoration Progress.

Project	Target	Mode	Treatment Type	Treatment Progress	Years of Operation	Groundwater Quality Highlights
OU III (cont.)						
Western South Boundary	VOCs	Operational (Pulse)	P&T with AS	49 lbs of VOCs treated to date	5 of 11	System continued in pulse pumping mode due to low VOC concentrations. Maximum TVOCs in monitoring well during 2007 was 45 µg/L.
Industrial Park	VOCs	Operational (UVB-1 on standby)	In-well stripping	1,010 lbs. of VOCs treated to date.	8 of 12	Marked increase in VOC levels in the vicinity of UVB-4.
Industrial Park East	VOCs	Operational	P&T with carbon t	33 lbs. of VOCs treated to date.	3.5 of 5	Continued decrease in VOC concentrations. All wells currently below the capture goal of 50 µg/L. Began pulse pumping in 2007. Installed new injection well in 2007.
North Street	VOCs	Operational	P&T with carbon	268 lbs. of VOCs treated to date.	3.5 of 8	High concentration segment of plume continues to be located in the capture zone of NS-1 and NS-2. Leading edge of plume beyond the capture zone prior to system start-up, migrating towards the Airport system.
North Street East	VOCs	Operational	P&T with carbon	20 lbs. of VOCs treated to date.	3.5 of 10	Concentrations in plume core wells at very low levels in 2007.
Long Island Power Authority (LIPA) Right of Way/ Airport	VOCs	Operational	P&T and recirculation wells with carbon	235 lbs. of VOCs treated to date.	3.5 of 10	Airport wells continued pulse pumping in 2007. Installed new extraction well in 2007 to address increasing VOCs in perimeter well 800-96 during 2006.
HFBR Tritium	Tritium	Operational	Pump and recharge	0.2 Ci removed for off-site disposal.* 180 lb of VOCs also removed from aquifer & treated.	3.5	Installed additional pump and extraction well. Restarted system in December 2007 response to triggering of OU III ROD contingency at Weaver Drive.
BGRR/Waste Concentration Facility (WCF)	Sr-90	Operational	P&T with IE	14.15 mCi to date	2.5 of 10	Identified area of higher than expected Sr-90 concentrations in downgradient portion of plume that will require system modification to achieve cleanup goal.

Continued

Table E-2 *(continued)***.**
Groundwater Restoration Progress.

Project	Target	Mode	Treatment Type	Treatment Progress	Years of Operation	Groundwater Quality Highlights
OU IV AS/SVE system	VOCs	Decommis-sioned	Air sparging/ soil vapor extraction	35 lb of VOCs removed.	Complete	VOC concentrations in monitoring wells remain low. System decommissioned in Dec. 2003.
OU V						
AOC 6/650 sump outfall	Sr-90	Long Term Response Action	Monitored Natural Attenuation (MNA)	Plume slowly migrating south within monitoring- well network.	NA	Sr-90 plume still migrating slowly southwest from Bldg. 650 sump outfall and attenuating.
OU V						
STP	VOCs, tritium	Long Term Response Action	MNA	NA	NA	Low-level VOC plume concentrations continued to slowly decline during 2007. Tritium continued to be detected in monitoring wells just above detection limits.
OU VI						
Ethylene Dibromide (EDB)	EDB	Operational	P&T with carbon	NA (due to minimal EDB in influent, no VOC removal is reported).	3.5 of 10	The highest EDB concentration in a monitoring well in 2007 was 2.3 µg/L, which continues a slow and steadily decreasing trend. Detections of EDB were observed in the extraction wells.

Notes:
AS = Air Stripping
AS/SVE = Air Sparging/Soil Vapor Extraction
HWMF = Hazardous Waste Management Facility (former)
IE = Ion Exchange
MNA = Monitored Natural Attenuation
NA = Not Applicable
NYS AWQS = New York State Ambient Water Quality Standards
P&T = Pump and Treat
RA = Removal Action
STP = Sewage Treatment Plant

* Off site removal of tritium was conducted during low-flow pumping events conducted in 2000 and 2001.

1.0 INTRODUCTION AND OBJECTIVES

The mission of Brookhaven National Laboratory's Groundwater Protection Program is to protect and restore the aquifer system at BNL. The program is summarized in the *BNL Groundwater Protection Management Program Description* (Paquette et al. 2002). 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 2007 Groundwater Status Report* is a comprehensive summary of groundwater data collected in calendar year 2007 that provides an interpretation of information on the performance of the Groundwater Protection Program. This is the twelfth annual groundwater status report issued by the Laboratory. This document is unique in that it examines performance of the program on a project-by-project (facility-by-facility) basis, as well as comprehensively in a "watershed-like" analysis.

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 Long Term Response Actions (LTRA) Group. This technical document is intended for internal users, regulators, and other technically oriented stakeholders. 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 drivers of the data collection work in 2007, the site's groundwater classification, and the objectives of groundwater monitoring. **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 2007. In **Section 3**, the groundwater cleanup data and progress towards achieving the site's cleanup goal 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 LTRA monitoring program. **Appendix D** contains analytical results for each sample obtained under the Environmental Surveillance 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 results also can be printed from the CD ROM. The groundwater results are arranged by specific monitoring project and analytical group: Volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), metals, general chemistry, pesticides/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. **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 2007 Environmental Monitoring Report for the Current and Former Landfill areas.

1.1 Groundwater Monitoring Program

1.1.1 Regulatory Drivers

Activities at BNL are driven by federal and state regulations as well as 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 of contaminated sites identified for priority cleanup. DOE, EPA, and NYSDEC created a comprehensive Federal Facilities Agreement that integrated DOE's response obligations under CERCLA, RCRA (the Resource Conservation and Recovery Act), and New York State hazardous waste regulations. The interagency agreement that was finalized and signed by these parties in May 1992 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 engineering 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 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, 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). EPA designated the Long Island aquifer system as a sole source aquifer in 1978, 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), NYS DWS, and NYS Ambient Water Quality Standards (AWQS) for Class GA groundwater.

For drinking water supplies, the applicable federal maximum concentration 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 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, Sr-90, and gross beta; the NYS AWQS for gross alpha, radium-226, and radium-228; and the 40 CFR 141/DOE DCGs for determining the 4 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. The Laboratory 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 data on groundwater quality 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 Surveillance

- 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 Restoration

- 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, thereby triggering contingency remedies to protect public health and the environment.

The details of the monitoring are described in the *BNL Environmental Monitoring Plan* (BNL 2007a). 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 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 in **Tables 1-5** and **1-6**. Screen zone, total depth, and ground surface elevations have been summarized for all monitoring wells in **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 BNL's Environmental Monitoring Plan. BNLs LTRA groundwater monitoring has been streamlined into five general phases of monitoring **(Table 1-8)**:

<u>Start-up</u>

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.

<u>Operations and Maintenance (O&M)</u>

This is a period of reduced monitoring during the time when the system is in a routine operational state and varies for each system. This phase is also utilized for several plume monitoring programs not requiring active remediation.

<u>Shutdown Monitoring</u>

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.

<u>Standby Monitoring</u>

This is a period of reduced monitoring over a five year duration to identify any rebounding of contaminant concentrations. If concentrations remain below MCLs the petition for closure and decommissioning of the system is recommend.

<u>Post Closure Monitoring</u>

This is a monitoring period of varying length for 20% of the key wells in a given project following system closure and continues until the ROD goal of meeting MCLs in the Upper Glacial aquifer by 2030 is reached. 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 has been using a structured Data Quality Objective (DQO) process to review and refine the groundwater monitoring and remediation projects. The results of the DQO reviews are documented annually in updates to the *BNL Environmental Monitoring Plan*.

Table 1-8. LTRA 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
	Plume Perimeter	2	4x
	Sentinel/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
	Plume Perimeter	2	4x
	Sentinel/Bypass	2	4x
System Standby Monitoring	Key Plume Core	5	2x
	Plume Perimeter	5	1x
	Sentinel/Bypass	5	2x
Post Closure Monitoring ***	20% of key wells	To 2030**	1x

Notes:
*- Varies by project, see schedule.
** - Magothy: 2070, BGRR Sr-90: 2075, S. Boundary Rad: 2038, Background: 2070, 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, and bypass 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 Detection – 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

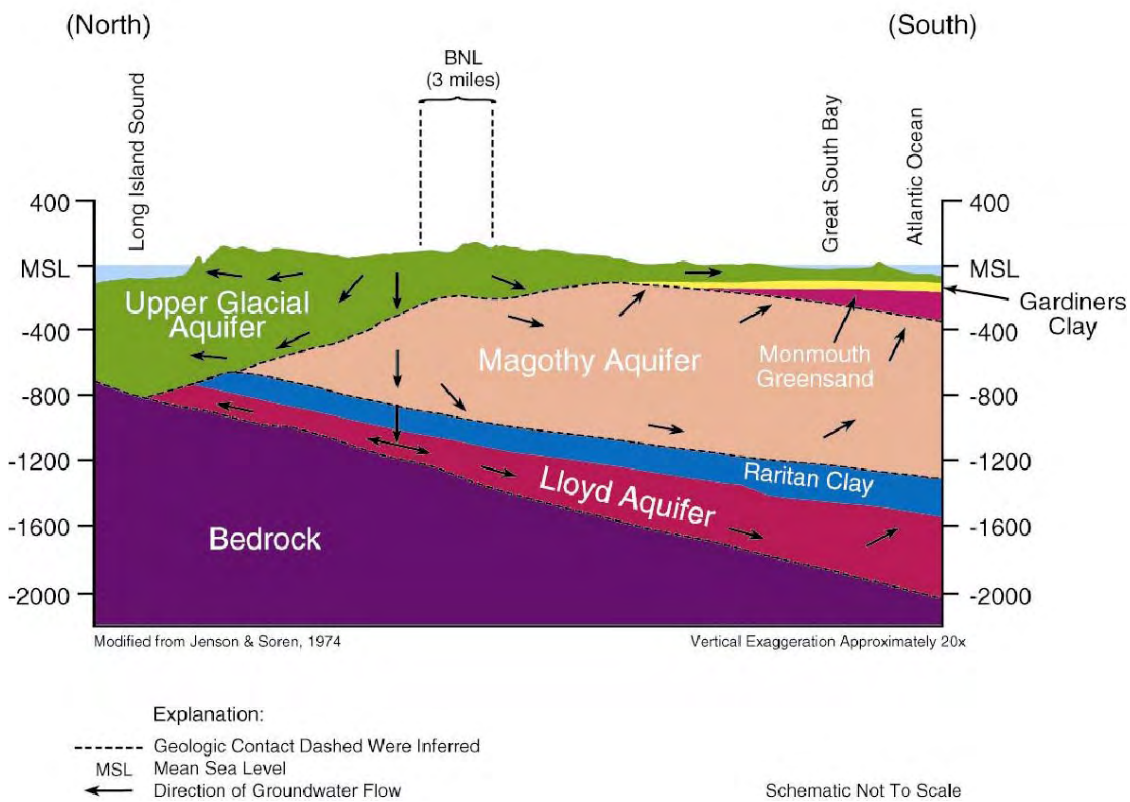
During 2007, there were eight known homeowners in the residential area overlying the plume who continue to use their private wells for drinking water purposes. In accordance with the OU III and VI RODs, annually DOE formally offers those homeowners free testing of their private drinking water wells. SCDHS coordinates and performs the sampling and analysis. The response rate to the annual letters sent to the homeowners over the several years has been low. Between one to two homeowners accept DOEs offer for annual sampling. During 2007, of the eight homeowners who were offered the free testing, only one requested the sampling. The results from SCDHS indicate that there were no VOCs detected.

2.0 HYDROGEOLOGY

This section briefly describes the improvements to our understanding of the hydrogeologic environment at BNL and the surrounding area. It also summarizes the dynamics of the groundwater flow system in 2007, along with on-site pumping rates and rainfall recharge.

Detailed descriptions, including the lithology and the geometry of the aquifer underlying BNL and its surrounding areas, are found in the U.S. Geologic 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**). Among these unconsolidated deposits, the current groundwater monitoring program focuses on groundwater quality within the Upper Pleistocene deposits, and the upper portions of the Matawan Group-Magothy Formation.

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 stratigraphic 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-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 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 contaminants 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 groundwater flow and movement of contaminants 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-water 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 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 2007 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 quarterly 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.

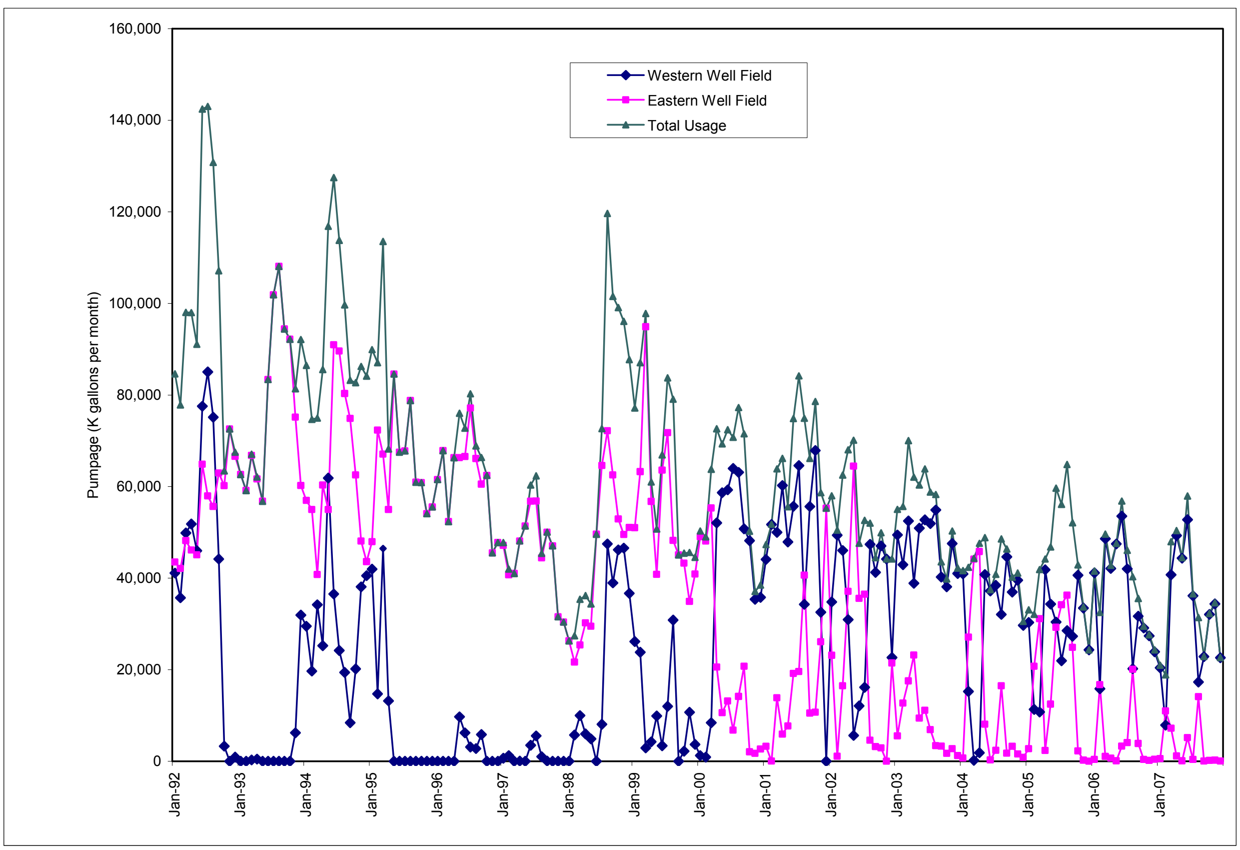
The quarterly synoptic water level measurement events comprising the complete network of on-site and off-site wells were reduced to a semi-annual event starting in 2006. This reduction was based on the fact that the Laboratory has compiled nearly 15 years of quarterly water level data, all planned groundwater remediation systems have been operational for at least 3 years and there has been little change to large-scale groundwater flow directions. The synoptic water level measurement rounds using the on-site and off-site monitoring well network were conducted from June 11 to 14, 2007 and December 3 to 6, 2007 with data collected from 771 and 774 wells, respectively. Reduced synoptic measurement efforts using wells located in the central part of the BNL site are also conducted semiannually. These data are important for monitoring any small scale changes to groundwater flow in the vicinity of known or potential contaminant source areas, and to collect data necessary for maintaining hydrographs for key wells. The BNL central area synoptic measurements were conducted on March 22, 2007 and September 24, 2007 with data collected from approximately 100 shallow glacial wells during these events. Water levels were measured with electronic water level indicators following the BNL *Environmental Monitoring Standard Operating Procedure* (EM-SOP-300). **Appendix A** has the depth-to-water (DTW) 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. Fourteen of the 61 treatment wells are 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 2007 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 section of the Upper Glacial aquifer. The variation in monthly pumpage primarily 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. 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 sitewide 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 2007.



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 2007, a total of 421 million gallons of water were withdrawn from the aquifer, and the Laboratory 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 90 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 (especially on the g-2 tritium plume and the Waste Concentration Facility Sr-90 plume). **Table 2-2** summarizes the 2007 BNL process water usage. **Table 2-3** summarizes the 2007 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 SCWA well fields are located near BNL. The two closest SCWA well fields are the William Floyd (Parr Village) Well Field and the Country Club Drive Well Field (see **Figures 2-2 and 2-3** for locations of the SCWA well fields). Other SCWA well fields (e.g., Lambert Avenue) are sited south of Sunrise Highway.

The William Floyd 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. 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 2007 is provided as **Figure 2-5.** In 2007, the William Floyd (Parr Village) and Country Club Drive Well Fields produced 469 and 471 million gallons for the year, respectively. Lambert Avenue produced 510 million gallons for the year.

2.1.4 Summary of On-Site Recharge and Precipitation Data

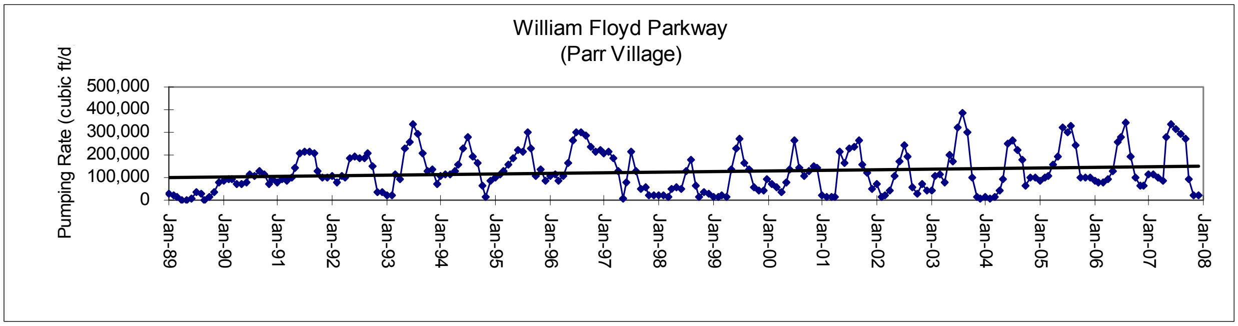
This section summarizes artificial (i.e., on-site recharge basins) and natural recharge from precipitation. **Table 2-4** summarizes the monthly and total flow of water through 10 on-site recharge basins during 2007. Their locations are shown on **Figures 2-2 and 2-3**. **Section 2.2** (Groundwater Flow) 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 the SPDES permit requirements. Generally, the amount of water recharging to 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*.

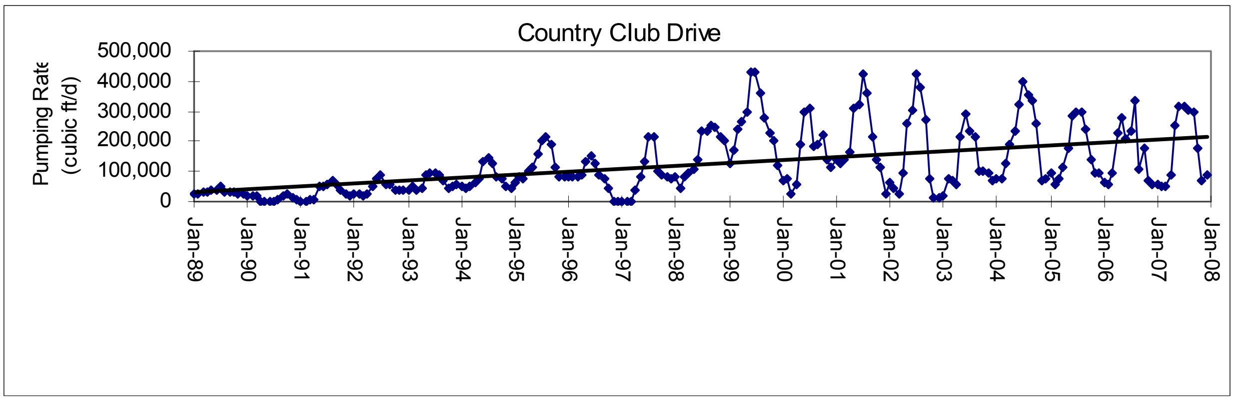
The remaining three basins (Removal Action V [RA V], OU III, and Western South Boundary) were constructed to recharge water processed through several of the groundwater remediation systems. Until September 2001, treated groundwater from the OU III South Boundary Pump and Treat System was discharged solely 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 Pump and Treat System 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 2-4** gives estimates of flow to these basins. The discharge to these basins for 2007 (14 and 9 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.

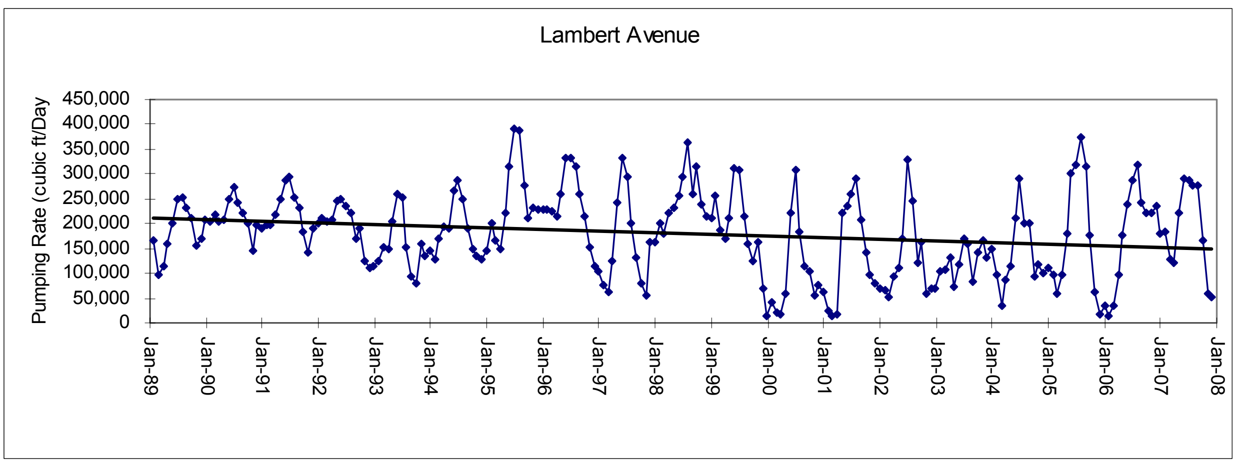
Other important sources of artificial recharge, not included in **Table 2-4**, include a stormwater retention basin referred to as HW (on Weaver Drive), and the sand filter beds at the STP. Basin HW causes localized mounding of the water table. At the sand filter beds, approximately 10 to 15 percent of the treated effluent (approximately 15 million gallons annually) seeps directly to the underlying water table via leaks in the underlying tile-drain collection system. The remaining treated effluent (approximately 130 million gallons annually) 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 rainfall 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 2007, it is estimated that the recharge at BNL was approximately 23 inches. **Table 2-5** summarizes monthly and annual precipitation results from

1949 to 2007 collected on site by BNL Meteorology Services. Variations in the water table generally can be correlated with seasonal precipitation patterns. As depicted in **Table 2-5**, total annual precipitation in 2007 was 45.3 inches, and is below the yearly average of 48.72 inches. Seven of the past 10 years have featured above-normal annual average precipitation at BNL.

2.2 Groundwater Flow

BNL routinely monitors horizontal and vertical groundwater flow directions and magnitudes 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 Maps

Figure 2-2 is a groundwater elevation contour map representing the configuration of the water table for December 2007. 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 shallow 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 2007 was consistent with historical flow patterns observed by SCDHS, USGS, and BNL. As described in **Section 2.1.2**, above, the water supply operating protocols established by BNL in late 2005 requires that the western well field be used as the primary source of water, with a goal of obtaining 75 percent or more of the water supply from these wells. This protocol resulted in a more stable south-southeast groundwater flow direction in the central portion of the site during all of 2006 and 2007.

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 Maps

Figure 2-3 shows the potentiometric surface contour maps of the deep zone of the Upper Glacial aquifer for December 2007. 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 patterns for groundwater flow in the deep Upper Glacial for 2007 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 maps also indicate 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 1950–2007) and short-term (1997–2007) 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. In 2006, the USGS installed a real time continuous water level recorder in BNL well ID 093-03 (USGS Site Number 405149072532201 - S5517.1), located adjacent to the southeast corner of BNL's Brookhaven Center building. Data from this monitoring station can be accessed on the world wide web at:

http://groundwaterwatch.usgs.gov/AWLSites.asp?S=405149072532201&ncd=rtn.

Six long-term hydrographs were constructed from historical water level data from wells installed and maintained by the USGS and BNL. These wells provide reasonable areal coverage for historical trends in areas both on site and surrounding BNL (just south of the southern boundary). The water level elevation data indicate water table fluctuations of 8 to 14 feet. The maximum observed variation of 14 feet reflects the regional drought that occurred in the 1960s. The minimum observed variation of 8 feet is more indicative of water level elevations fluctuations that have occurred since the late 1970s.

Quarterly data on water levels collected during 2007 were used to construct nine short-term hydrographs from three well clusters (well cluster 75-39/-40/-41, 105-05/-07/-24, and 122-01/-04/-05). Generally, the highest groundwater elevations can be observed during the March time period. Based on data from both long- and short-term hydrographs, water table elevations in the BNL vicinity in 2007 showed a steady decline through the year. This is in contrast to 2006 when water levels were the highest observed since 1997 and just below some of the highest recorded water elevations observed since record keeping began in the late 1940s (**Table 2-5)**.

2.3 New Geologic Data

No new geologic data were collected during 2007. However, several temporary wells were drilled in early 2008 to augment the geologic information in the area of Building 96. Several more are planned for this area in mid 2008.

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3.0 ENVIRONMENTAL RESTORATION GROUNDWATER MONITORING AND REMEDIATION

Chapter 3 gives an overview of groundwater monitoring and remediation efforts at BNL during calendar year 2007. 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 and by project. Monitoring well location maps specific to particular monitoring programs are included throughout Chapter 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. Users can print a hardcopy of the results from the CD ROM. The groundwater results are arranged by specific monitoring project and then by analytical group (VOCs, SVOCs, metals, chemistry, pesticides/PCBs, and radionuclides). The data are organized further by well ID and the date of collection 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 (see **Section 1.1.1** [Regulatory Drivers]) are in bold text. Inclusion of the complete results allows the reader to analyze them in detail. 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 volatile organic compound (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 all the individual 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

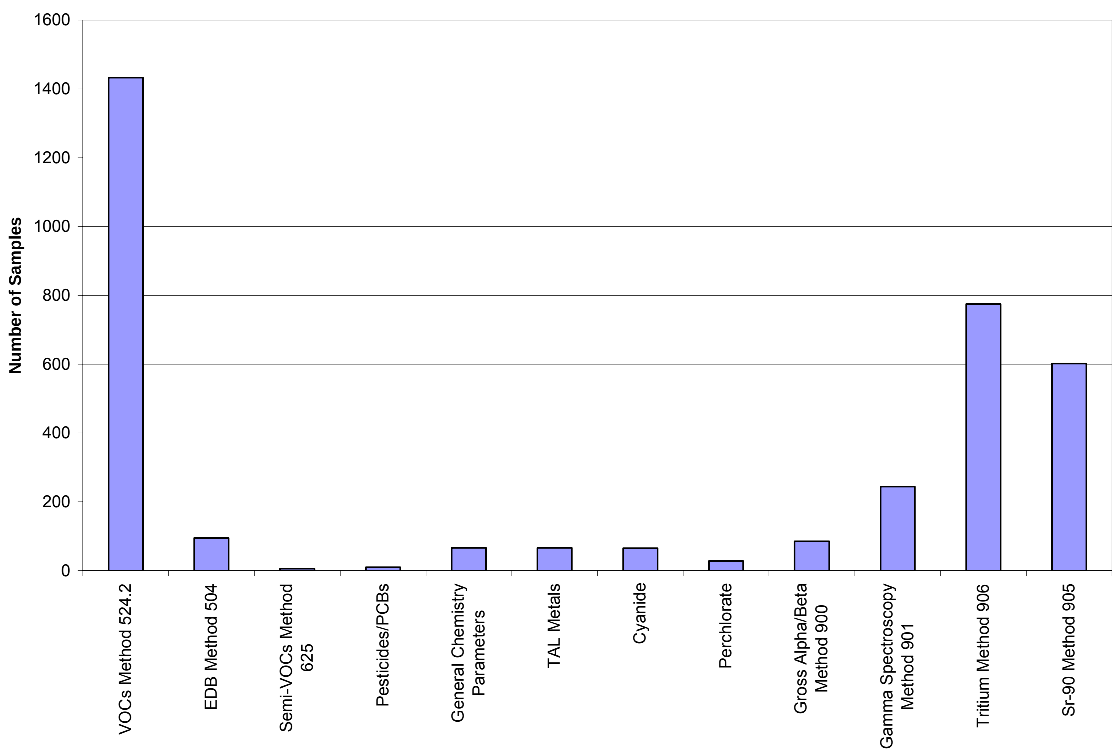
Additionally, BNL's ability to accurately depict these plumes has been enhanced over the years by the:

- addition of permanent monitoring wells to the existing well networks
- installation of temporary wells during groundwater characterization efforts that helped to fill in data gaps

During 2007, the contaminant plumes were tracked by collecting 2,049 groundwater samples obtained from 725 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 2007 data from permanent monitoring wells. In several cases, data from the first three months of 2008 were utilized. Contaminant plumes associated with HFBR Tritium, BGRR/WCF Sr-90, and Bldg. 96 projects were further defined in 2007 using temporary wells (i.e., direct push Geoprobes or vertical profiles).

A single representative round of monitoring data was 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 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 Environmental Surveillance Monitoring Program are also evaluated in Section 4.0.

Figure 3.0-2.
Summary of Laboratory Analyses Performed for the Environmental Management Program in 2007.



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, within 30 years or less (by 2030), to prevent or minimize plume growth and not to exceed MCLs in the Upper Glacial aquifer. 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 within 70 years (by 2070) and 40 years (by 2040), respectively. In addition, cleanup of the Magothy aquifer VOC contamination must meet MCLs within 65 years (by 2065).

There are currently 14 groundwater remediation systems in operation. The last treatment system, for the on-site BGRR/WCF Sr-90 plume, began operations in 2005. One system remains in standby mode (the Carbon Tetrachloride Pump and Treat System). 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 Plant Engineering personnel perform routine maintenance checks on the treatment systems daily, in addition to their routine and non-routine maintenance. BNL's Environmental and Waste Management Services Division (EWMSD) collects the treatment system performance samples (influent, midpoint, effluent). 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.

Table 3.0-1 summarizes the operating remediation systems. Groundwater remediation at BNL is proceeding as predicted.

Table 3.0-1. 2007 Summary of Groundwater Remediation Systems at BNL.

Operable Unit System	Type	Target Contaminant	No. of Wells	Years in Operation	Recharge Method	Pounds VOCs Removed (Year/Cum)
Operable Unit I						
South Boundary	P&T, AS	VOC	2	10	Basin	6/337
Operable Unit III						
South Boundary	P&T, (AS)	VOC	7	10	Basin	32/2569
HFBR Pump and Recharge	Pump and Recirculate	Tritium	4	Operate: 3.5 Standby: 6.5	Basin	0/180
Industrial Park	Recirculation/ In-Well (AS/Carbon)	VOC	7	8	Recirculation Well	43/1010
*Carbon Tet	P&T (Carbon)	VOC	3	Operate: 5 Standby: 3	Basin	NA/349
Building 96	Recirculation Well (AS/Carbon)	VOC	4	Operate: 4 Standby: 3	Recirculation Well	<1/71
Middle Road	P&T (AS)	VOC	6	6	Basin	34/741
Western South Boundary	P&T (AS)	VOC	2	5	Basin	4/49
Chemical Holes	P&T (IE)	Sr-90	3	5	Dry Well	0.27**/2.60
North Street	P&T (Carbon)	VOC	2	3.5	Wells	36/268
North Street East	P&T (Carbon)	VOC	2	3.5	Wells	4/19
LIPA/Airport	P&T and Recirc. Wells (Carbon)	VOC	10	3.5	Wells and Recirculation Well	35/237
Industrial Park East	P&T (Carbon)	VOC	2	3.5	Wells	4/32
BGRR/WCF	P&T (IE)	Sr-90	5	2.5	Dry Wells	4.9**/14.2
Operable Unit VI						
EDB	P&T (Carbon)	EDB	2	3.5	Wells	NA***

Notes:
AS = Air Stripping
AS/SVE = Air Sparging/Soil Vapor Extraction
EDB = ethylene dibromide
IE = Ion Exchange
LIPA = Long Island Power Authority
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.

NA = Not Applicable
* This system was shut down August 1, 2004 and put in standby mode.
** Sr-90 removal is expressed in mCi.
*** DB was only detected in the system influent in 2007 well below the standard. Therefore, no removal of VOCs is reported.

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 become commingled south of the former HWMF. The commingling was partially caused by the pumping and recharge effects of the Spray Aeration System, which operated from 1985 to 1990. This system was designed to treat VOC-contaminated groundwater originating from the former HWMF. The TVOC plume is depicted in **Figure 3.1-1**. A segment of the plume extends off site, approximately 3,400 feet south of the site property boundary.

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 (see **Section 3.2.9**).

Tritium was detected in several on-site monitoring wells at concentrations below the 20,000 pCi/L DWS in 2007. Sr-90 is detected in on-site wells, one of which exceeded the 8 pCi/L DWS in 2007, 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 2007 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, 2007 through September 30, 2007. 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 44 monitoring wells (**Figure 1-2).** A discussion of monitoring well data specific to the Current Landfill source area is provided in **Appendix H**.

Sampling Frequency and Analysis

The wells are monitored as per the schedule provided in **Table 1-5**.

3.1.4 Monitoring Well VOC Results

Figure 3.1-1 shows the areal extent of TVOC contamination from the Current Landfill/former HWMF area based on the full round of samples collected in the third and fourth quarters of 2007. The primary VOCs detected in the on-site segment of this plume include chloroethane and DCA, which originated from the Current Landfill. TCA, DCE, TCE, and chloroethane are prevalent in the off-site segment of the plume (North Street East). TVOC concentrations less than 40 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 TVOC plume appears to be attenuating to levels below 5 µg/L approximately 1,000 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 and monitoring well 098-59 to the site boundary (a distance of approximately 2,260 feet), where it has been hydraulically cut off from the off-site segment of the plume by extraction wells EW-1 and EW-2. Its maximum width is about 750 feet at the southern site boundary. The plume segments with higher TVOC concentrations (greater than 50 µg/L) are approximately 300 feet wide. The areas of the plume displaying the highest TVOC concentrations (greater than 100 µg/L) were approximately 1,200 to 2,400 feet downgradient of the former HWMF. Contaminant concentrations near well 098-59 have declined significantly, indicating that the trailing edge of the high concentration segment is continuing to migrate away from this area and toward the site boundary. 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 2007 analytical results for the 44 wells. Significant findings for 2007 include:

- The trailing edge of the OU I South Boundary plume appears to have migrated south of plume core well 098-59 (**Figure 3.1-3**) based on the last several years of data. This well began to show a steadily decreasing trend in TVOC concentrations during 2002 after peaking at 371 µg/L in 1997, as a high-concentration slug of contaminants continues to migrate southward. The third-quarter 2007 TVOC concentration in this well was 2 µg/L and the concentration has remained below 7 µg/L since the third quarter of 2005. This well is screened in the Upton Unit immediately above the Gardiners Clay.
- Monitoring well 107-40 was installed to assist in defining the VOC hot spot migration south of well 098-59 and was sampled for the first time in 2006. The initial TVOC concentration of 108 µg/L in this well has slowly increased to 135 µg/L in the fourth quarter of 2008. The levels of VOCs detected in this well are indicative of the plume hot spot continuing to move through this area and toward the extraction wells.
- 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 just above detection limits in 2007. TVOCs in well 115-41 increased slightly to 7 µg/L during the fourth quarter of 2007. VOCs greater than DWS continue to be hydraulically contained at the site boundary.

3.1.5 Radionuclide Monitoring Results

The monitoring wells were 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 all wells continues to be well below the 20,000 pCi/L DWS. Tritium concentration in well 098-30 (immediately south of former HWMF) continued the slight increasing trend begun in 2006 with a detection of 9,210 pCi/L in the fourth quarter. Concentrations in well 108-12 (located along the South Firebreak Road) which slightly increased in 2006 from nondetectable levels up to 6,210 pCi/L declined to barely detectable levels in 2007. The tritium in these wells most likely represent the attenuated remnants of tritium concentrations originating from the former HWMF.

Tritium has historically been detected in wells 115-14, 115-29, and 108-12, located near the site boundary, at concentrations well below the DWS. The maximum concentrations in wells 115-14 and 115-29 during 2007 were 1,820 pCi/L and 1,710 pCi/L, respectively. These concentrations reflect the continued steady decline over the past several years. Concentrations have also declined in well 108-12 (maximum of 840 pCi/L in 2007), following a brief spike in 2006. 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 (including six that are also part of the OU I South Boundary Monitoring Program) used to monitor Sr-90 contamination from the former HWMF **(Table 1-5)**. The extent of Sr-90 concentrations is shown on **Figure 3.1-5**. Sr-90 has historically been detected in three wells located within and downgradient of the former HWMF (088-26, 098-21, and 098-30) at concentrations above the 8 pCi/L DWS. Well 088-26 was the only one of the three to show Sr-90 concentrations above the DWS, with a maximum concentration of 13 pCi/L in August 2007. Sentinel monitoring wells were installed in 2002, downgradient of the leading edge of the plume. 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 have slowly increased to 6 pCi/L in December 2007, which indicates that a slug of Sr-90 originating from the former HWMF is in the vicinity of this well This sentinel well is approximately 1,000 feet from the site boundary, equivalent to 25–30 years of travel time in the aquifer. Sr-90 concentration trends for key monitoring wells are provided in **Figure 3.1-6**.

Table 3.1-1.
OU I South Boundary Pump and Treat System 2007 SPDES Equivalency Permit Levels

Parameters	Permit Level	Max. Measured Value
pH	6.0 – 9.0 SU	6.9 – 7.9 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.

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 3.1-1** provides the effluent limitations for meeting the requirements of the State Pollutant Discharge Elimination System (SPDES) equivalency permit. The system resumed full time operation in July 2007 following a period of pulse pumping that was initiated in September 2005.

The following is a summary of the OU I operations for 2007:

January–September 2007

The system operated normally during the first three quarters. The system was in a pulse pumping mode one month on and one month off until July 2007 when full time operations resumed. In August the system experienced problems in EW-2 which led to the system being shut off in late September for well maintenance and repair.

October–December 2007
The system was off in October and part of November while well repairs and maintenance were being conducted. The system operated normally for all of December.

3.1.7 System Operational Data

Extraction Wells
During 2007, 137 million gallons of groundwater were pumped and treated by the OU I system, with an average flow rate of 260 gpm for the year. Typical flows while operating are 550–600 gpm. **Table 2-3** contains the monthly pumping data for the two extraction wells. VOC and tritium concentrations in samples from EW-1 (115-27) and EW-2 (115-43) are provided in **Table F-1** in **Appendix F**. TVOC levels in both wells continued to show a slight decreasing trend with time (**Figure 3.1-7**). Year-end tritium levels were below detection limits in both wells.

System Influent and Effluent
VOC concentrations in 2007 for the air-stripper influent and effluent are summarized in **Tables F-2** and **F-3** in **Appendix F**. Tritium data for influent and effluent samples are shown in **Table F-4**. The influent concentrations of TCA and DCA generally have displayed an overall decrease over the 10 years of OU I South Boundary System operation.

The air-stripper system effectively removed all contaminants from the influent groundwater. All effluent data were below the analytical method detection limit and below the regulatory limit specified in the equivalency permit conditions.

Cumulative Mass Removal
The mass of VOCs removed from the aquifer by the OU I treatment system was calculated. 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 3.1-8**). During 2007, 6.4 pounds of VOCs were removed. Cumulatively, 337 pounds have been removed since 1997. Groundwater modeling estimated that the system would remove between 300 to 350 pounds by 2006–2007. Cumulative mass removal data for this system are summarized in **Table F-5**.

Table 3.1-2
OU I South Boundary System
2007 Air Stripper VOC Emissions Data

Parameter	Allowable ERP* (lb/hr)	Actual** ERP* (lb/hr)
Carbon tetrachloride	0.016	<0.0002
Chloroform	0.0086	<0.0002
1,1-Dichloroethane	10**	0.00035
1,2-Dichloroethane	0.011	<0.0002
1,1-Dichloroethene	0.194	<0.0002
Chloroethane	10**	0.0004
1,1,1-Trichloroethane	10**	<0.0002
Trichloroethene	0.119	<0.0002

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.
*** 6 NYCRR Part 212 restricts emissions of VOCs to a maximum of 10 lb/hr without controls.

Air Discharge
Table 3.1-2 presents the VOC air emissions data for the year 2007 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. All 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. The highest detection of tritium during 2007 was 550 pCi/L in well 076-172, which is slightly above the detection limit. Beginning November 1, 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. This basin resumed receiving water from the HFBR Tritium Pump and Recharge Wells in 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. Pulse pumping was discontinued in July 2007 per the recommendations in the 2006 Groundwater Status Report.

The OU I South Boundary Pump and Treat 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. 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 2007.

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 2007; thus, the 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 in **Figure 3.0-1** . The capture zone depicted includes the 50 µg/L isocontour that 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 hydraulic capture performance of the system is operating as previously modeled and the system continues to be effective in capturing and removing VOCs from the deep Upper Glacial aquifer. In 2003, the beginning of a steady decline in VOC concentrations in well 098-59 was observed. This decline continued in 2007 and it appears that the trailing edge of this high concentration segment has migrated south of this area. Monitoring well 107-40 was installed in 2006 and is used to track this high concentration segment as it migrates to the south boundary. The system resumed full-time operation in 2007 based on increasing VOC concentrations in well 107-40. VOC concentrations in EW-1 and EW-2 were observed to remain stable; however, it is anticipated that there will be some increase in concentrations in the near future as the hot spot arrives at the site boundary. Based on monitoring well results and mass removal of contaminants, 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?
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 in **Figure 3.1.9**. Changes in the distribution of the plume are shown in **Figure 3.1-10**, which compares the TVOC plume from 1997 to 2007.

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 3.1-9**).

4c. How many individual plume core wells are above 50 μg/L?
Monitoring well 107-40, which was installed in 2006, is the only plume core well to have TVOC concentrations exceeding 50 μg/L. TVOC concentrations are currently increasing 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 to allow the plume hot spot detected in well 107-40 to migrate south to the extraction wells. The arrival of the hot spot should result in some increase in VOC concentrations in EW-1 and -2.

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. However, MCLs are expected to be achieved by 2030.

3.1.9 Recommendations

The following are recommendations for the OU I South Boundary Pump and Treat System and groundwater monitoring program:

- Based on TVOC concentration increases in upgradient plume core well 107-40 the leading edge of the high concentration segment of the VOC plume is approaching the south boundary and should arrive in the near future. As a result, full-time operation of extraction wells EW-1 and EW-2 will continue until further notice.
- Install vertical profile well approximately 500 feet north of well 107-40 along the Princeton Avenue Firebreak Road to locate the centerline of the VOC high concentration slug. Install a monitoring well if TVOCs are greater than 50 μg/L.
- The routine operation and maintenance monitoring frequency implemented in the fourth quarter of 2004 should be continued. Plume core and perimeter wells are monitored on a semiannual frequency. Sentinel and bypass wells are sampled at a quarterly frequency. Maintain a quarterly sampling frequency for well 107-40 to monitor the hot spot.
- Reduce frequency of Sr-90 sampling for wells 107-34, 107-35, 108-43, 108-44, 115-41, and 115-42 from quarterly to semi-annually, due to the absence of Sr-90 in these wells. Drop Sr-90 analysis for all other off-site wells due to absence of Sr-90. Reduce tritium sampling in bypass wells 115-41 and 115-42 from quarterly to semi-annually.

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 several sources, including Building 96, the Warehouse area, 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 simplified 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, 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 2007. 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 10-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 is evidenced by the break in the plume in this area.
- The attenuation of the on-site potion of the North Street VOC plume.
- The migration of the off-site higher VOC concentration slug from the vicinity of Moriches–Middle Island Road in 1997 to the Airport Treatment System extraction wells in 2007.

Three radiological plumes were addressed under Operable Unit III. The HFBR tritium plume extends several thousand feet south from the HFBR spent fuel pool. Sr-90 plumes are present downgradient of the former Waste Concentration Facility (WCF) and several sources related to the Brookhaven Graphite Research Reactor (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.

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3.2.1 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 on October 6, 1999 and was formally shut down and placed in standby mode on August 1, 2004 after receiving regulatory approval of the petition for shutdown. This summary is prepared annually and discusses the monitoring data from January 1, 2007 through December 31, 2007.

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. As was recommended in the petition to shut down the carbon tetrachloride system, two monitoring wells (095-300 and 095-301) were installed in the vicinity of extraction well EW-15 in 2004. Well 095-300 was installed to monitor the western edge of the plume in the vicinity of well EW-15, and well 095-301 was installed upgradient of well EW-15.

Sampling Frequency and Analysis

The wells are sampled quarterly (shutdown phase), and samples are analyzed for VOCs (see **Table 1-5**).

3.2.1.3 Monitoring Well Results

Carbon tetrachloride is the primary contaminant in this plume. However, there are also low levels of chloroform (a breakdown compound of carbon tetrachloride). The plume extends from the former UST southeast to the vicinity of the Weaver Drive recharge basin, a distance of approximately 1,300 feet (**Figure 3.2.1-1**). The width of the plume, as defined by the 50 μg/L carbon tetrachloride isocontour, is approximately 100 feet. The complete 2007 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 2007 follows:

- Plume core well 085-98, just south of the former UST, had carbon tetrachloride concentrations greater than 150,000 μg/L in 1999. A dramatic reduction in concentrations has been observed in this well, beginning in 1999 with the start of groundwater pump and treat. The concentration of carbon tetrachloride was 11 μg/L in October 2007 (**Figure 3.2.1-2**).
- Plume core well 085-17 is sited next to the BNL service station on Rochester Avenue and downgradient of the source area. It has continued to show declining carbon tetrachloride trends from a peak of more than 4,000 μg/L in 2000 to a concentration of 41 μg/L in October 2007 **(Figure 3.2.1-2)**. Of note on this well is that other compounds related to petroleum products are also detected in this well and this is due to the service station located in this area (see Section 4.8).
- Plume core well 85-161 is approximately 120 feet downgradient of the source area. Concentrations in this well have remained low throughout 2007, with a concentration of 2.8 μg/L in October 2007.
- Plume core well 095-183 is approximately 450 feet downgradient of the source area. Carbon tetrachloride concentrations in this well have decreased from greater than 2,000 μg/L in 2000, to <0.5 μg/L in October 2007 **(Figure 3.2.1-2)**.

- Plume perimeter wells 095-300 and core well 095-301 were installed in 2004, as recommended in the *Petition to Shutdown the Carbon Tetrachloride System* (BNL 2004j). Well 095-300 was installed west of EW-15 to confirm the western edge of the carbon tetrachloride plume. The analytical results for this well show a carbon tetrachloride concentration of .65µg/L in October 2007, thus confirming the western edge of the plume. Well 095-301 was installed to monitor concentrations of the plume immediately upgradient of well EW-15. Concentrations of carbon tetrachloride varied from 37 µg/l in January to 1.1 µg/L in October 2007.

3.2.1.4 System Operations

Operating Parameters

In 2007, the extraction wells were sampled quarterly. All samples are analyzed for VOCs. The extraction well data is located in **Table F-6**. The parameters for sampling pH and VOCs adhere to the requirements of the SPDES equivalency permit. However, the system was in standby in 2007. The system operations are summarized below.

January – December 2007

The system was in standby mode during this period. Sampling for the SPDES equivalency permit was stopped and will be resumed if the system is restarted.

3.2.1.5 System Operational Data

The system was shut down for the entire year so no data are available

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 ran for approximately one month in 2005. The system remained in standby mode for all of 2006 and 2007. The groundwater extraction wells will remain on a quarterly sampling schedule to monitor for any significant rebound in concentrations of carbon tetrachloride.

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 2007 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.

3. Has the plume been controlled?

Yes. The plume has been controlled, and the system is in standby mode.

4. Is the system operating as planned?

The system is currently shut down and being maintained in standby mode. Shutdown of the system at these concentrations is consistent with meeting the OU III ROD cleanup objectives of meeting MCLs by 2030.

5. Is an engineering evaluation needed to modify the Middle Road treatment system to ensure the capture and remediation of the carbon tetrachloride plume?

Based on data from bypass and Middle Road tracking wells, no engineering study is required at this time. The Middle Road system will capture any higher levels of carbon tetrachloride not captured by this system.

3.2.1.7 Recommendations

The following are recommendations for the OU III Carbon Tetrachloride Groundwater Remediation System and monitoring program:

- Maintain the system in standby mode. If significant concentrations of carbon tetrachloride are detected in monitoring or extraction wells, the system will be turned on.
- Move monitoring well 095-92 to the Middle Road Pump and Treat System well network.
- Perform two to four temporary wells in the center of the plume north of extraction well EW-15 and south of well 85-17. These data will be used to help perform the recommended modeling evaluation below.
- Perform groundwater modeling to evaluate if the remaining levels of contaminants in this area can meet the cleanup objectives through natural attenuation. If it can be demonstrated by the model that the current levels will achieve these objectives, then a petition for closure of this system will be submitted to the regulators.

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3.2.2 Building 96 Air Stripping System

This section summarizes the 2007 operational data from the OU III Building 96 Treatment System, which consists of recirculation wells 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. Three of the four recirculation wells (RTW-2, RTW-3, and RTW-4) were placed in standby mode in July 2004 and the fourth recirculation well (RTW-1) was initially placed in standby mode on June 1, 2005 and remained in standby until it was restarted October 17, 2005 due to a rebound in VOC concentrations. As noted in **Section 3.2.2.4**, well RTW-1 was placed back in standby mode in June 2006, and downgradient well RTW-2 was re-started on October 15, 2007 due to a rebound in VOC concentrations.

Characterization results identified a shallow low permeability zone, referred to as the "silt zone." Monitoring data indicate that high concentrations of VOCs are present in this zone and provide a continuing source of VOCs to groundwater. Due to the continuing source of VOC contamination in the silt zone, three injections of the oxidizer potassium permanganate ($KMnO_4$) were conducted from December 2004 through January 2006. Based on the monitoring well data since then, these injections were not successful in reducing the high VOC concentrations in the silt zone

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 below land surface (bls), near the base of the contaminant plume. The groundwater then is pumped into a stripping tray adjacent to each of the four wells, and after treatment is recharged back to the shallow portion of the plume, 25 to 35 feet bls, through the upper screen. The contaminated air stream is then carried to a treatment and control building, where it is passed through two vapor phase granular activated carbon 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 *Building 96 Groundwater Source Control Treatment System Operations and Maintenance Manual* (BNL 2002a). A modification to this manual was prepared and is titled, *Operations and Maintenance Manual Modification, Building 96* (BNL 2004c).

3.2.2.2 Groundwater Monitoring

The monitoring network of 33 wells is used to monitor the VOC plume and the effectiveness of the groundwater remediation system (**Figure 1-2**). The wells are sampled and analyzed for VOCs on a quarterly frequency, in accordance with **Table 1-5**.

3.2.2.3 Monitoring Well Results

Complete VOC results are provided in **Appendix C** . Since sufficient data has been collected following the $KMnO_4$ injections, the monitoring well sampling frequency was changed from monthly to quarterly, effective the third quarter of 2006. The fourth-quarter 2007 plume is shown on **Figure 3.2.2-1**. A summary of key monitoring well data for 2007 follows:

- The highest TVOC concentration seen in 2007 was 3,543 µg/L, from well 085-347, during the third quarter sampling round. Although this is significantly high, it is approximately half of the maximum concentration seen in 2005 and 2006 of 7,173 µg/L and 8,754 µg/L, respectively, in well 085-353. Historically, the highest concentration seen in this area was 18,000 µg/L TVOCs, in well 095-84 in October 1998. As shown in trend **Figure 3.2.2-2**, plume core monitoring wells 085-347, 085-353, and 095-84 continue to show significant rebounding of contaminant levels over the last few years. Based on this data, the $KMnO_4$ injections have not been effective in the silt zone.
- TVOC concentrations in plume core well 085-352 (screened in the silt zone) began rebounding in 2007 to 1,330 µg/L after two years of 285 µg/L or less in 2005 and 2006. The same can be said

for well 085-349, which rose to 1,718 µg/L in 2007. This helps demonstrate continued leaching of PCE from the silt zone.

- Plume core wells 095-162 and 095-172 (located between recirculation wells RTW-1 and downgradient wells RTW-2 through RTW-4) began increasing in 2006 and 2007 after several years of less than 50 µg/L TVOCs. This is due to the plume passing by RTW-1 while it remains in standby mode. Maximum TVOC concentrations in these well in 2007 were 136 µg/L and 196 µg/L, respectively. This contamination will be captured by the downgradient recirculation treatment wells.
- Plume perimeter well 095-295, located on the west side of the plume, maintained low TVOC concentrations throughout 2006 and 2007. The highest 2006 and 2007 TVOC concentrations in well 095-295 were 9.8 µg/L and 5.9 µg/L, respectively. The bypass monitoring wells immediately downgradient of extraction wells RTW-2, RTW-3, and RTW-4 detected TVOC concentrations in 2007 up to 119 µg/L in the western portion of the plume, 122 µg/L in the center portion, and 142 µg/L in the eastern portion of the plume**.** As a result of increasing contamination in this portion of the plume, downgradient well RTW-2 was placed back in service in October 2007, and RTW-3 and RTW-4 were placed back in service in February 2008.
- Data from three temporary wells (Geoprobes) installed in February 2008 along Weaver Drive identified TVOC concentrations up to 91 µg/L in GP-01. See **Section 3.2.2.4** below for discussion on the purpose of the Geoprobes.

3.2.2.4 System Operations

Operating Parameters

Three of the four downgradient recirculation wells (RTW-1, RTW-3, and RTW-4) remained in standby mode in 2007. Due to a rebound in VOC concentrations in the downgradient portion of the plume, recirculation well RTW-2 was put back on in October of 2007, and RTW-3 and RTW-4 were placed back in service in February 2008. As noted in the 2006 *Groundwater Status Report*, the continued operation of RTW-1 as a recirculation well may be causing adverse impacts on the plume. As a result, RTW-1 has remained in standby mode since June 2006.

January –September 2007

The system was in standby mode for this entire period.

October –December 2007

Extraction well RTW-2 was placed back on-line in October and pumped approximately 2.8 million gallons for the quarter.

As recommended in the 2006 *Groundwater Status Report*, to maintain hydraulic containment of the source area, in the fall of 2007 BNL began preparing design drawings to modify recirculation well RTW-1 to discharge the treated effluent to the nearby surface drainage culvert. This involves running a discharge line to the culvert about 300 feet away and requires a SPDES equivalency permit.

During metals sampling in late November 2007 to support the submittal of an equivalency permit application, total chromium (Cr) was detected up to 185 µg/L in a RTW-1 effluent sample. The groundwater standard is 50 µg/L and the SPDES limit is 100 µg/L.

On December 12, 2007, RTW-1 effluent resample results from two different labs indicated hexavalent chromium Cr(VI) at 124 µg/L and 131 µg/L. In accordance with the BNL Groundwater Contingency Plan, on the December 20, 2007 IAG teleconference, the regulators were informed of the sampling results and next steps. Subsequent actions performed over the next couple of months included:

- Resampling RTW-1 as well as the remaining three recirculation wells for total Cr and Cr(VI).
- Comprehensive sampling of all the Bldg. 96 monitoring wells for Cr(VI).

- Installation of three temporary wells (Geoprobes) along Weaver Drive to determine the downgradient extent of the Cr(VI) contamination.
- Evaluate the source of the Cr(VI) in the Bldg. 96 area.
- Evaluate technologies to treat Cr(VI) prior to discharge to the culvert.

The data suggest that the most likely cause of the elevated Cr(VI) levels was the treatment of soils with $KMnO_4$. One of the byproducts of the reaction is manganese oxide, which oxidizes trivalent chromium to Cr(VI). It is expected that over time, the Cr(VI) will revert back to trivalent chromium (the less toxic form). In January and March 2008 the regulators were briefed on the results of the follow-up actions. The results from the monitoring well and Geoprobe sampling indicated that the detections of Cr(VI) is not widespread, but rather is localized as a result of the previous KMnO4 injections. The highest Cr(VI) detection in a Bldg. 96 monitoring well was 389 µg/L, in well 095-169. The three Geoprobes installed along Weaver Drive did not detect any Cr(VI). The monitoring well data from January 2008 and the February 2008 Geoprobe data are posted on **Figure 3.2.2-5.**

As a result, in February 2008 the design modification for RTW-1 was submitted to the regulators, along with the SPDES equivalency permit application. In addition to VOC treatment using air stripping, ion exchange resin will be used to treat the Cr(VI) prior to discharge. NYSDEC approved the SPDES permit in March 2008.

As recommended in the 2006 *Groundwater Status Report*, an evaluation of alternatives to remediate the continuing source of VOCs in the silt zone was initiated. This evaluation looked at various alternatives such as soil excavation, an additional extraction well, soil mixing with vapor extraction, electrical resistance heating, and injection by hydrogen release compounds.

3.2.2.5 System Operational Data

Recirculation Well Influent and Effluent

Three of the four recirculation wells (RTW-1, RTW-3, and RTW-4) remained in standby mode in 2007. Recirculation well RTW-2 was placed back into operation in October 2007. **Table F-7** lists the quarterly influent and effluent VOC concentrations for all of the recirculation wells. The highest TVOC concentration from the influent of these wells was 174 µg/L in RTW-1 in the fourth quarter. The maximum TVOC in the influent of the downgradient wells was 28 µg/L in RTW-3. Note that RTW-4, which was placed back on-line in February 2008, detected influent TVOCs up to 121 µg/L in March 2008. The highest effluent TVOC concentration was from RTW-2, at 2 µg/L, from December 2007.

Cumulative Mass Removal

RTW-2 was the only recirculation well running during 2007. Since it ran for just three months, mass removal was not calculated. The pumping and mass removal data are summarized in **Table F-9** in **Appendix F**. Since February 2001, the system has removed approximately 71 pounds of VOCs.

Air Treatment System

Air sampling was performed in December of 2007 and the analytical data are available in **Appendix F** , **Table F-8**. Since RTW-2 ran for only three months, the emissions rate was not calculated (**Table 3.2.2-1**).

3.2.2.6 System Evaluation

A review of the Building 96 treatment well influent and monitoring well data indicated that the remedial effectiveness of RTW-1 had reached a plateau without significant impact on the high concentrations of a continuing source of VOCs located in the silt zone of the aquifer upgradient of RTW-1. Therefore, in an attempt to reduce the high concentrations of VOCs, primarily PCE, in the silt zone area upgradient of RTW-1, the injection of $KMnO_4$ was conducted (BNL 2004d). Three rounds of $KMnO_4$ injections were conducted in the silt zone area upgradient of extraction well RTW-1 in December 2004, April 2005, and January 2006.

The locations for the three rounds of $KMnO_4$ injections are shown on **Figure 3.2.2-2.** Also, a cross section that includes this area is shown on **Figure 3.2.2-3.**

After three rounds of $KMnO_4$ injections followed by a full year of continued monitoring in 2007, elevated VOC concentrations (primarily PCE) are still present in the northern part of the silt zone upgradient of RTW-1 near wells 085-347 and 085-353. The highest TVOC concentration in this area in 2007 was 3,543 µg/L in well 085-347.

As described in the 2006 *Groundwater Status Report*, the $KMnO_4$ injections did not effectively address the continuing source of VOCs in the silt zone. A comparison of the plume from 2000 to 2007 is shown in **Figure 3.2.2-4.**

The OU III Building 96 Treatment System performance can be evaluated based on the two major decisions identified by applying the DQO process.

Table 3.2.2-1.
OU III Building 96
VOC Emission Rates, 2007 Average

Parameter	Allowable ERP*	Actual** ER
dichlorodifluoromethane	0.0000187	3.4
acetone	0.000674	ND
methylene chloride	0.000749	1.1
2-butanone	0.000187	ND
benzene	0.000112	3.8
tetrachloroethene	0.000165	ND
m,p-xylene	0.0000116	ND
isopropylbenzene	0.000243	ND
n-propylbenzene	0.0000599	ND
1,3,5-trimethylbenzene	0.000375	1.1
1,2,4-trimethylbenzene	0.000225	2.6
4-isopropyltoluene	0.00000749	ND
naphthalene	0.0000225	ND
carbon disulfide	0.0000487	ND
styrene	0.00000637	ND
trans-1,3-dichloropropane	0.0000157	ND

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
NS = Not sampled

1. Was the BNL Groundwater Contingency Plan triggered?

Yes. As noted above, during the Nov/Dec 2007 sampling of RTW-1 influent, Cr(VI) was identified above the groundwater standard, triggering the Groundwater Contingency Plan. This was significant, since Cr(VI) was not previously detected as a contaminant of concern in this area and cannot be treated with the existing system. Following communication with the regulators, additional monitoring well and temporary well sampling was performed. Based on the data, ion-exchange resin treatment will be included for RTW-1.

2. Have the source control objectives been met?

No. Based on the goals established in the *Building 96 Groundwater Source Control Operations and Maintenance Manual* (BNL 2002a), as updated by the *Operations and Maintenance Manual Modification Building 96* (BNL 2004c), the source control goals for this system have not been met. Based on monitoring data, the $KMnO_4$ injections have not been effective in remediating the PCE concentrations in the shallow silt zone. As a result, a continuing source of high VOC contamination still exists in this area.

3.2.2.7 Recommendations

The following are recommendations for the OU III Building 96 groundwater remediation system and monitoring program:

- In the spring of 2008 implement the modification to recirculation well RTW-1 to work as a pumping well with Cr(VI) treatment, and discharge to the nearby surface drainage culvert. In addition to the existing air stripping treatment for VOCs, this will involve the installation of ion-exchange treatment vessels for Cr(VI), and running a discharge line to the culvert about 300 feet away. Effluent sampling frequency will be performed as per the approved SPDES equivalency permit. Once Cr(VI) concentrations drop below allowable discharge levels and all monitoring wells in the vicinity of the pumping well are below these levels, treatment for chromium will be eliminated.
- Continue monitoring well sampling at the current quarterly frequency, and add total Cr and Cr(VI) to the analysis.
- Maintain operation of downgradient recirculation wells RTW-2, RTW-3, and RTW-4. Continue operation until TVOC concentrations <50 µg/L are seen in the recirculation wells' influent and adjacent monitoring wells. Maintain a monthly sampling frequency of the influent and effluent for each well when they are operating. When in standby mode reduce the sampling to quarterly.
- In the spring of 2008, perform soil borings at the location of the highest VOC contamination and analyze the silt zone soil cores for VOCs. Geophysical logs and soil cores will be obtained to determine detailed lithology. These data will aid in precisely defining the nature and extent of the source area, which is critical to determine the most cost-effective remedial alternative for this area. In addition, one well will be installed to help evaluate the effectiveness of using soil vapor extraction technology in this area.
- Following the collection of the source area analytical and geological data, complete an evaluation of alternative methods for remediating the contamination in the silt zone upgradient of extraction well RTW-1. This evaluation will include excavation of the source area, adding an additional extraction well in the source area, and evaluating other remedial technologies. The evaluation will be prepared in 2008.
- Following the determination of the remedial action to address the VOCs in the silt zone, update the project DQOs.
- Add a core monitoring well west of well 095-172 to determine VOC concentrations just upgradient of RTW-2.

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3.2.3 Middle Road Pump and Treat System

The Middle Road Groundwater Pump and Treat System began operating on October 23, 2001. This section summarizes the operational data from the Middle Road system for 2007, 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. On September 30, 2003, extraction wells RW-4 and RW-5 were placed in standby mode due to low concentrations of VOCs. In September 2006, well RW-6 was also placed in standby mode due to low VOC concentrations. The system is currently operating at a pumping rate of approximately 300 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 23 monitoring wells located between the Princeton Avenue firebreak road and the OU III South Boundary Pump and Treat System (**Figure 1-2**).

The 23 Middle Road wells are sampled and analyzed for VOCs. Nine of the wells are sampled quarterly, and the others are sampled semiannually. Several wells are also utilized in the OU III HFBR Tritium Monitoring Program (**Table 1-5**).

3.2.3.3 Monitoring Well Results

The complete VOC results are shown 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 available monitoring well data (**Figure 3.2-1**). TVOC concentrations in monitoring wells east of RW-3 are generally below 10 µg/L. VOC concentrations have generally continued to decline in 2007. Results for key monitoring wells are as follows.

- The highest TVOC concentration detected was in bypass detection well 113-11, at 424 µg/L in October 2007. 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 179 µg/L.
- 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 42 µg/L in the fourth quarter of 2007 (**Figure 3.2.3-1)**.
- TVOC concentrations in plume core wells to the east of well 105-23, along Princeton Avenue, were generally below 100 µg/L in 2007. TVOC concentrations decreased in well 105-44, from 423 µg/L in 2001 to 9 µg/L in the fourth quarter of 2007 (**Figure 3.2.3-1)**.

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 in **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.

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. In addition, system influent samples are analyzed for tritium during each system-sampling event. Tritium remains below detection limits in all samples. All effluent concentrations from the treatment system during this period of operation were below equivalency permit levels except for pH (**Table 3.2.3-1**).

Approximately 128 million gallons of water were pumped and treated in 2007 by the OU III Middle Road System. The following paragraphs summarize the Middle Road System operations for 2007.

January–September 2007

The system was off in August and September due to electrical repairs and numerous electrical storms that knocked out electric and communications to the system. Approximately 84 million gallons of water were treated.

October – December 2007

The system operated normally and pumped and treated approximately 43 million gallons of water during this quarter. The system was down in December due to communication problems between the extraction wells and stripping tower.

Table 3.2.3-1.
Middle Road Air Stripping Tower
2007 SPDES Equivalency Permit Levels

Parameters	Permit Limit	Max. Observed Value
pH range (SU)	6.5–8.5	6.75 – 7.44
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.

3.2.3.5 System Operational Data

System Influent and Effluent

All parameters in the SPDES equivalency permit limits were within the specified ranges during 2007. **Figure 3.2.3-4** plots the concentrations of TVOCs in the extraction wells versus time.

Results from samples collected from the extraction wells are found on **Table F-10 (Appendix F).** The influent VOC concentrations remained constant over the reporting period. The average TVOC concentration in the influent during 2007 was 46 µg/L (see **Table F-11**). The results from sampling the influent and effluent are summarized in **Tables F-11** and **F-12**, 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 248 gpm during 2007 (**Table 2-3**, and **Table F-13**), and approximately 34 pounds of VOCs were removed. Approximately 741 pounds of VOCs have been removed since the system began startup testing on October 23, 2001. The cumulative total of VOCs removed vs. time is plotted in **Figure 3.2.3-3**.

Air Discharge

Table 3.2.3-2 shows the air emissions data from the system for the OU III Middle Road tower during 2007, and compares the values to levels stipulated in NYSDEC Air Guide 1 regulations. Emission rates are obtained through mass-balance calculations for all water treated during that time (**Table F-10**). The concentration of each constituent was averaged for 2007, and those values were used in determining the emissions rate. All air emissions were below permitted limits.

Table 3.2.3-2.
Middle Road Air Stripper
VOC Emission Rates, 2007 Average

Parameter	Allowable ERP* (lb/hr)	Actual** (lb/hr)
carbon tetrachloride	0.022	0.0002
chloroform	0.0031	0.0001
1,1-dichloroethane	10***	0.000026
1,2-dichloroethane	0.008	0.000002
1,1-dichloroethylene	0.034	0.0001
cis-1,2-dichloroethylene	10***	0.0001
trans-1,2-dichloroethene	10***	0
tetrachloroethylene	0.387	0.0041
1,1,1-trichloroethane	10***	0.0005
trichloroethylene	0.143	0.0002

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.

Extraction Wells

Extraction wells RW-4 and RW-5 were shut down on September 30, 2003 and placed on standby due to low concentrations of VOCs. The extraction wells, including wells RW-4 and RW-5, 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 remained constant over the reporting period for the operational wells.

3.2.3.6 System Evaluation

The system has been operating since October 23, 2001. Groundwater mapping indicates that hydraulic control has been achieved.

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 and extraction wells associated with the OU III Middle Road Pump and Treat System during 2007.

2. Has the plume been controlled?

Yes. VOC concentrations in plume perimeter wells remained stable at low concentrations during 2007, indicating that the plume is being controlled. High VOC 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. 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 in **Figure 3.0-1**. The capture zone includes the 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 system is operating as planned based on the mass removal of VOCs. Monitoring wells continue to show generally decreasing concentration trends during 2007.

4. Can the groundwater treatment system be shut down?
No, the system has not met all shutdown requirements (see 4a through 4d).

4a. Have asymptotic VOC concentrations been reached in core wells?
No. 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)?
Yes, the average TVOC concentration for the plume core wells was 47 µg/L (**Figure 3.2.3-5**).

4c. How many individual plume core wells are above 50 µg/L?
Three of the 14 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?
The OU III Middle Road System has not been pulsed, to date.

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 began in 2003.
- Maintain extraction wells RW-4, RW-5, and RW-6 in standby mode during 2008. Restart the wells if extraction or monitoring well data indicate that TVOC concentrations exceed the 50 µg/L capture goal.
- Install a temporary well about 100 feet to the west of well 113-09 to confirm the western edge of the OU III plume in this area. Based on the results of this temporary well, additional sampling or another permanent monitoring well may be required.
- Install a temporary well several hundred feet upgradient of RW-1 to locate a permanent well(s) in this area to provide for monitoring of VOCs migrating toward RW-1.

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 2007, 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 on June 17, 1997. It utilizes air-stripping technology for treatment of groundwater contaminated with chlorinated solvents. The water is pumped from seven extraction wells. The system is currently operating at a pumping rate of approximately 500 gpm, utilizing five extraction wells. Extraction well EW-12 was placed on standby during October 2003, and EW-8 in October 2006 due to low VOC concentrations. Wells EW-6 and EW-7 were placed in standby mode in November and December 2007 as per recommendations in the 2006 report. 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 38 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 in **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. Individual VOC concentrations in the plume perimeter wells were less than 5 µg/L except for well 121-08, which had a concentration of TCA at 7.1 µg/L in October 2007 (TVOC at 24 µg/L) (**Figure 3.2.4-1**). This is still well below the capture goal of the system of 50 µg/L TVOC. VOCs were detected in the deep Upper Glacial aquifer in the vicinity of the site boundary, as depicted in **Figures 3.2-2, 3.2. 4-1, and 3.2.4-2. Appendix C** has the complete groundwater monitoring results for 2007.

The plume core wells continued to show the same trend of decreasing VOC concentrations that were observed following the startup of the pump and treat system in 1997, with several exceptions. The bulk of the VOC contamination in this area is currently located between EW-3 and EW-5, as can be seen in **Figure 3.2.4-2 ,** which is a cross section (F–F') drawn along the south boundary and incorporating the extraction wells. The VOC concentration trends for specific key wells are shown in **Figure 3.2.3-1.** Results for key monitoring wells are as follows:

- Plume core well 114-07 is immediately upgradient of EW-12. Increasing VOC concentrations in this well during 1998 prompted the addition of EW-12, which began pumping in December 1999. TVOC concentrations in 2007 remained below the NYS AWQS, with no VOCs exceeding NYS AWQS since 2001. EW-12 was placed on standby in October 2003.
- 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 startup concentration of 1,617 µg/L. VOC concentrations have remained very low, with no VOC exceedances of NYS AWQS since 2002.
- Plume core well 122-19 is directly downgradient of EW-8. TVOC concentrations were as high as 367 µg/L in 1997; VOCs have not been detected above standards since 2002.

- Plume core well 122-04 is located between EW-7 and EW-8. VOC concentrations remained low during 2007 with the highest concentration being a detection of PCE at 6.2 µg/L in April 2007. Concentrations dropped to 3.9 µg/L in October 2007.
- Plume core well 121-23 is immediately downgradient of EW-5. During 2007, the TVOC concentrations ranged between 53 and 85 µg/L. The primary contaminant observed is PCE. This is consistent with the contaminants in EW-4 and EW-5.
- Plume core well 121-13 is immediately upgradient of, and between, EW-4 and EW-5. TVOC concentrations in this well have fluctuated somewhat since 1997, peaking at 1,098 µg/L in 1999. The recent PCE concentration in this well ranged from 780 µg/L in June 2005 to 3.1µg/L in October 2007. PCE is the primary compound in wells 121-13, 121-23, EW-4, and EW-5. This rapid rise and then fall in concentrations of PCE represents a slug of contamination migrating into this area.
- A new monitoring well (OU III SBMW-01-2006) was installed in 2006 to monitor the higher VOC concentrations seen at well 113-17 and 113-11. The well is located between the Middle Road and South Boundary systems. The 2007 results showed TVOC concentrations as high as 474 µg/Lin July 2007 **(see Figure 3.2-2)**.
- Plume core well 121-11 is upgradient of EW-3. TVOC concentrations ranged from 6 µg/L in April 2007 to approximately 23 µg/L in October 2007.
- Bypass detection wells 122-34 and 122-35, south of EW-8, were below NYS AWQS for VOCs from 2003 through 2007.
- Plume core well 122-05 is a Magothy monitoring well west of EW-8. TVOC concentrations have been showing a declining trend with concentrations at 25 µg/L in October 2007.

Table 3.2.4-1.
OU III South Boundary Air Stripping Tower 2007 SPDES Equivalency Permit Levels

Parameters	Permit Limit*	Max. Observed Value
pH range(SU)	6.5 – 8.5	6.9–7.6
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

*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.

3.2.4.4 System Operations

The individual extraction wells are sampled quarterly, and all samples are analyzed for VOCs. The effluent sampling parameters of pH and VOCs are done monthly, in accordance with SPDES permit equivalency requirements (**Table 3.2. 4-1**). In addition, samples are analyzed for tritium with each system-sampling event. In all samples, tritium continues to remain below analytical reporting limits. All effluent VOC concentrations from the treatment system during this period of operation were below permit equivalency requirements.

System Operations

Approximately 136 million gallons of water were pumped and treated in 2007 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.

January–September 2007

Approximately 95 million gallons of water were pumped and treated. There were communications and electrical problems during this period, which resulted in the system being off for the month of September.

October 2007-December 2007

The OU III South Boundary System pumped and treated approximately 42 million gallons of water. There were electrical problems with EW-4 during this quarter, which resulted in well maintenance and repair. In addition, well EW-6 was put on standby in November and EW-7 in December, due to low VOC concentrations.

Table 3.2.4-2.
OU III South Boundary Air Stripper VOC Emission Rates, 2007 Average

Parameter	Allowable ERP*	Actual** ER
carbon tetrachloride	0.022	0.0005
chloroform	0.0031	0.0001
1,1-dichloroethane	10***	<0.0002
1,2-dichloroethane	0.008	<0.0002
1,1-dichloroethylene	0.034	0.0002
cis-1,2-dichloroethylene	10***	0.0001
trans-1,2-dichloroethylene	10***	0
tetrachloroethylene	0.387	0.0032
1,1,1-trichloroethane	10***	0.0005
trichloroethylene	0.143	0.0001

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.
*** 6 NYCRR Part 212 restricts emissions of VOCs to a maximum of 10 lb/hr without controls.

3.2.4.5 System Operational Data

System Influent and Effluent

Figure 3.2.4-3 plots the concentrations of TVOCs in the extraction wells versus time. The overall influent water quality and the individual extraction wells show a general declining trend of concentrations. The system was also sampled monthly for tritium, which was not detected above the reporting limit in any sample during 2007. System influent and effluent sampling results are summarized in **Tables F-15** and **F-16**, 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 (see **Table F-17**). The cumulative total of TVOCs removed by the treatment system versus time is plotted in **Figure 3.2.4 -4**. The 2007 total was approximately 32 pounds. Cumulatively, the system has removed approximately 2,569 pounds since it was started on June 17, 1997.

Air Discharge

Table 3.2.4-2 shows the air emissions data from the OU III South Boundary for 2007, and compares the values to levels stipulated in NYSDEC Air Guide 1 regulations. Emission rates are obtained through mass-balance calculations for all water treated during that time (**Table F-15**). The concentration of each constituent was averaged for the year, and that value was used in the calculation. All air emissions were below allowable levels.

Extraction Wells

In general, the extraction wells continued to show slowly decreasing VOC concentrations during 2007 (**Figure 3.2.4-3**). **Table F-14** in **Appendix F** summarizes the data for the extraction wells.

3.2.4.6 System Evaluation

The pump and treat system continues to maintain hydraulic control and continues to prevent further plume migration across the southern site boundary. Plume core and bypass wells continued to show stable or decreasing VOC concentrations. The system operated at an average of 252 gpm during 2007. There was some significant downtime due to electrical problems and scheduled maintenance. No permit equivalency standards were exceeded and some operating difficulties were experienced due to electrical problems. There have been no air emission exceedances.

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 2007.

2. Has the plume been controlled?
Yes. The capture zone for the OU III South Boundary Pump and Treat System is depicted in **Figure 3.0-1**. The capture zone depicted includes the 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 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 2007 it had operated for approximately 10.5 years. The system is removing contamination at the expected rate and hydraulic control of the plume was demonstrated; hence, it is operating as planned. The duration of operation for the OU III South Boundary System is dependent on the effectiveness of the Middle Road Groundwater Treatment System, and the travel time from the 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 five 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 from over 1,300 µg/L.

The trend in the mean of the TVOC concentrations in the core groundwater monitoring wells is declining (**Figure 3.2.4-5**).

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. The average TVOC concentrations of the OU III South Boundary wells continued a decreasing trend in 2007 (**Figure 3.2.4-5**).

4b. Is the mean TVOC concentration in core wells less than 50 µg/L?
Yes. Starting in late 2005 and continuing through 2007 **(Figure 3.2.4-5)**.

4c. How many individual plume core wells are above 50 µg/L?
Two core wells, 121-23 and SBMW-01, have 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?
The OU III South Boundary System has not been pulsed to date.

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 the routine operations and maintenance monitoring frequency that began in 2003.
- Extraction well EW-12 was placed in standby mode in 2003 and EW-8 in 2006. Wells EW-6 and EW-7 were placed on standby at the end of 2007. These wells will continue in standby mode during 2008. The wells will be restarted if extraction or monitoring well data indicate TVOC concentrations exceed the 50 µg/L capture goal.
- Maintain wells EW-6, EW-7, EW-8 and EW-12 in standby mode. All extraction wells will continue to be sampled on a quarterly basis.

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3.2.5 Western South Boundary Pump and Treat System

The Western South Boundary Pump and Treat System was designed to capture VOCs exceeding 20 µg/L TVOC in the Upper Glacial aquifer along a 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.

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 17 wells is used to monitor this portion of the plume. Their locations are shown in **Figure 1-2**. 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 portion of the plume are dichlorodifluoromethane (freon), 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 2007 monitoring well concentrations. A summary of key monitoring well data for 2007 follows:

- Plume core wells 121-42, 126-13, 127-04, and 127-06 have been generally decreasing in concentrations since the treatment system was started in 2002. TVOCs in wells 121-42 and 127-06, located upgradient of extraction well WSB-2, have remained around 20 µg/L since 2005. TVOC concentrations in core well 126-15, located midway between the two extraction wells, has remained consistently low, below 5 µg/L from 2002 through most of 2006. In late 2006 and 2007, the concentrations began increasing but still remained below 20 µg/L TVOC.
- TVOC concentrations in plume core well 126-14, located upgradient of WSB-1, have decreased slightly since system start-up, but have remained elevated above 20 µg/L. TVOC concentrations in plume core well 126-11, located adjacent to WSB-1, dropped off significantly since system start-up; however, it began increasing since 2006 and reached 27 µg/L in the fourth quarter 2007 (see **Figure 3.2.5-1**). The highest TVOC detection of the seven plume core wells was 31 µg/L in well 126-14 in April 2007.
- Maximum TVOC concentrations during 2007 were found in bypass detection well 130-08, located south of extraction well WSB-1, at 45 µg/L during the third quarter. The highest VOC detected was dichlorodifluoromethane, at 25 µg/L.
- TVOC concentrations in bypass detection well 126-16 dropped-off to its lowest level in four years: 19 µg/L in the first quarter of 2007 but it increased slightly over the year. Plume bypass well 127-07, located downgradient of WSB-2, has been steadily declining in TVOC concentrations since 2005. In the third and fourth quarter of 2007, TVOCs dropped to less than 10 µg/L. If any of the three bypass detection wells starts showing increasing trends, the need to take further action will be evaluated.
- Plume perimeter well 130-03, located west of extraction well WSB-1, detected a maximum TVOC concentration in 2007 of 29 µg/L in April. This is a decreasing trend from the historical high of 58 µg/L TVOC in December 2004. The capture zones of the Western South Boundary extraction wells were not intended to include this area.

- Plume perimeter wells 119-03 and 125-01 monitor the groundwater quality in the vicinity of the OU III Western South Boundary recharge basin. There have been no detections of VOCs exceeding NYS AWQS for these wells since they were installed in 2002.

3.2.5.4 System Operations

During 2007, the extraction wells were sampled quarterly. The influent and effluent of the air-stripper tower were sampled twice per month in May, but due to a scheduling error, the system was only sampled once per month when the system was running in February, July, and November. The system was placed in standby mode for pulse pumping the remainder of the time. All samples were analyzed for VOCs. In addition, the effluent sample was analyzed for pH and tritium twice a month. No tritium was detected in 2007. **Table 3.2.5-1** provides the effluent limitations for meeting the requirements of the SPDES equivalency permit. All effluent discharges met the SPDES equivalency permit requirements. The system operations are summarized as follows:

Table 3.2.5-1.
Western South Boundary Pump & Treat System 2007 SPDES Equivalency Permit Levels

Parameter	Permit Level (µg/L)	Max. Measured Value (µg/L)
pH range	6.5–8.5 SU	6.7–7.1 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

Required effluent sampling frequency is 2x/month for VOCs and monthly for pH.

January–September 2007
The treatment system operated normally from January to September. The system has been in a pulse pumping schedule since 2005. The schedule is one month on and two months off.

October–December 2007
The system was off in October and December as part of the pulse pumping schedule. Normal system operations were conducted in November and the system operated without interruption.

3.2.5.5 System Operational Data

Extraction Wells
During 2007, approximately 71 million gallons of groundwater were pumped and treated by the OU III Western South Boundary System, with an average flow rate of approximately 259 gpm while in operation. **Table 2-3** gives monthly pumping data for the two extraction wells. VOC and tritium concentrations for extraction wells WSB-1 (126-12) and WSB-2 (127-05) are provided in **Table F-18** in **Appendix F** (on the CD-ROM). VOC levels in both wells continued to show a slight decreasing trend since system start-up in 2002, through 2006. Since 2006 through mid 2007 there has been a slight increasing trend; however, in May 2007 the TVOC concentrations began dropping off. TVOC extraction well concentrations typically ranged between 8 to 19 µg/L for 2007 (see **Figure 3.2.5-3** for a graph of extraction wells trends over time). Most of the individual VOC compounds were either below or slightly above the NYS AWQS .

System Influent and Effluent
All influent TVOC concentrations were less than 18 µg/L, and individual VOC concentrations were less than the NYS AWQS, except for May 2007 data that detected TCA at 5.5 µg/L. These levels are consistent with the historical influent concentrations. The influent consists primarily of freon, TCA, TCE, and chloroform (**Tables F-19** and **F-20**, **Appendix F**).

The air-stripper system effectively removed all elevated contaminants from the influent groundwater. All effluent data were below the analytical method detection limit and below the regulatory limit specified in the equivalency permit conditions.

Cumulative Mass Removal
The mass of VOCs removed from the aquifer by the treatment system was calculated. 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 removed per month (**Table F-21, Appendix F**). The cumulative mass of VOCs removed by the treatment system is provided in **Figure 3.2.5-2**. During 2007, four pounds of TVOCs were removed; a total of 49 pounds have been removed since the startup of the system in 2002.

Air Discharge
Table 3.2.5-2 presents the VOC air emission data for the year 2007 and compares the values to levels stipulated in NYSDEC Air Guide 1 regulations. Emission rates are calculated through mass balance for all water treated during operation. The concentration of each constituent of the air-stripper's influent was averaged for the year. That value was converted from µg/L to lb/gal, which was multiplied by the average pumping rate (gal/hr) to compare with the regulatory value. All VOC air emissions were well below allowable levels.

Table 3.2.5-2.
Western South Boundary
2007 Air Stripper VOC Emissions Data

Parameter	Allowable ERP* (lb/hr)	Actual ERP (lb/hr)
carbon tetrachloride	0.016	<0.0002
chloroform	0.0086	0.0002
1,1-dichloroethane	10**	<0.0002
1,2-dichloroethane	0.011	<0.0002
1,1-dichloroethene	0.194	0.0003
chloroethane	10**	<0.0002
1,1,1-trichloroethane	10**	0.0005
trichloroethene	0.119	0.0002

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.

3.2.5.6 System Evaluation

The system has been fully operational since September 2002, and pulse pumping was initiated in late 2005. 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 Contingency Plan triggered?
No. There were no unusual or unexpected VOC concentrations observed in the monitoring wells associated with the Western South Boundary Treatment System during 2007.

2. Has the plume been controlled?
Yes. VOC concentrations in all of the plume perimeter wells except 130-03 remained stable at or less than the drinking water standard during 2007, indicating that the plume is being controlled. Perimeter well 130-03 has been slowly decreasing since late 2004 to a low of 27 µg/L in the fourth quarter 2007. The capture zone of WSB-1was 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 in **Figure 3.0-1**.

3. Is the system operating as planned? Specifically, is the aquifer being restored at the planned rate?
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 except for well 126-11 in 2006 and 2007. Increasing VOCs in monitoring wells immediately upgradient of WSB-1 (i.e., 126-11 and 126-14) will be captured by the system.

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 TVOC concentrations in core monitoring wells and the extraction wells (see 4a through 4b).

4a. Have asymptotic VOC concentrations been reached in core wells?
No. As noted in Section 3.2.5.3 above, all core monitoring wells have been steadily decreasing since the system became operational in mid 2002, except for well 126-11. This well, immediately upgradient of WSB-1, has been steadily increasing since 2006. Extraction wells WSB-1 and WSB-2 have shown generally steady and low concentration trends since 2002 between approximately 10 µg/L and 25 µg/L TVOCs, respectively. However, there was a slight increase in TVOC concentrations in both extraction wells starting in late 2005 through mid 2007. Most of the extraction well and influent individual VOC data have been below the NYS AWQS.

4b. Is the mean TVOC concentration in core wells less than 20 µg/L?
No, although five out of seven core wells have been below 20 µg/L TVOCs for the past 18 months.

4c. How many individual plume core wells are above 20 µg/L TVOCs?
TVOC concentrations in two of seven core wells were above 20 µg/L. Wells 126-11 and 126-14, just upgradient of extraction well WSB-1, showed TVOCs up to 27 µg/L and 31 µg/L, respectively, in 2007 .

4d. During pulsed operation of the system, is there significant concentration rebound in core wells?
Yes. As noted above, plume core well 126-11 has been steadily increasing since 2006, shortly after pulse pumping began. The highest TVOC concentration in 2007 was 27 µg/L. TVOC concentrations in the extraction wells increased slightly since 2006; however, they remained below 20 µg/L in 2007.

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:

- Based on increasing TVOC concentrations (i.e., >20 µg/L) in core well 126-11 in 2007, return extraction well WSB-1 to on full-time operation. Continue pulse pumping 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 starts showing increasing trends, the need to take further action will be evaluated.
- As there have been no detections of VOCs exceeding NYS AWQS for plume perimeter wells 119-03 and 125-01 since they were installed in 2002, VOC analysis will be discontinued. These wells monitor the groundwater quality in the vicinity of the OU III Western South Boundary recharge basin. Also, since background well 124-02 has not had any detections of VOC above the NYS AWQS, this parameter will be dropped.
- Maintain the routine O&M monitoring frequency that began in 2005.

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 2007 and presents conclusions and recommendations for its future operation. The system began operation on September 27, 1999. The OU III Industrial Park system was designed to contain and remediate the portion of OU III plume existing between BNL's southern boundary and the southern boundary of the Parr Industrial Park. **Figure 3.2.4-1** illustrates the extent of the OU III contaminant plume in the vicinity of the Industrial Park.

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 granular activated carbon (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 *Operation and Maintenance Manual for the OU III Off-Site Removal Action* (BNL 2000b).

3.2.6.2 Groundwater Monitoring

Well Network

The monitoring well network consists of 40 wells and is designed to monitor the VOC plumes in the vicinity of the industrial park south of the site, and also 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, shown in **Figure 3.2.4-1.** 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 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 2007. Based on these data, the plume is effectively bounded by the current well network. **Figure 3.2.4-1** shows the plume distribution based on fourth-quarter 2007 data. The vertical extent of contamination is shown in **Figure 3.2.6-1**. The location of this cross section (G–G') is illustrated in **Figure 3.2-1 and 3.2.4-1**. 2007 Results for key monitoring wells are as follows.

Plume Core Wells

- Wells 000-253 (just east of UVB-1) and 000-256 (between UVB-1 and UVB-2), which had both shown concentrations in 2001 well over 1000 µg/L TVOC, have continued to show concentrations at or below NYS AWQS. Since 2003, UVB-1 has remained in standby.
- Well 000-259, which was sampled in May and November 2007 (between UVB-2 and UVB-3), had elevated concentrations of 297µg/L and 193 µg/L TVOCs, respectively. 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 4 µg/L in November 2007 (**Figure 3.2.6-2**).
- Well 000-262 (between UVB-4 and UVB-5) began showing decreasing TVOC concentrations in 2002 (**Figure 3.2.6-2**). TVOC concentrations in this well peaked at 2,175 µg/L in 2001 and dropped to 211 µg/L in November 2006; however, in 2007 this well showed a marked increase to 408 µg/L in May and 695 µg/L in November.
- The TVOC concentration in well 000-268 (between UVB-6 and UVB-7) was 78 µg/L in November 2007 (**Figure 3.2.6-2**). These data are 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 2007. Wells 000-431 and 000-432 serve as bypass monitoring points downgradient of UVB-2. Well 000-432 has shown TVOC concentrations between 4 µg/L and 10 µg/L during 2007. TVOC concentrations in 000-431 were below NYS AWQS during 2007. The low TVOC concentrations in these wells indicate that the system is effective in hydraulically controlling the plume.
- TVOC concentrations in wells 000-275, -276, -277, and -278 are all below the capture goal of 50 µg/L, indicating that the system is effective in capturing the plume. The highest concentration observed was 14.5 µg/L (January 2007), in well 000-277.
- Wells 000-273 and -274 have shown an increasing concentration trend. Well 000-273 went from 15 µg/L in March 2006 to 375 µg/L TVOC in November 2006, and as expected down to 54 µg/L in November 2007. Well 000-274 increased from 20 µg/L in March 2006 to 143 µg/L in November 2006. This well declined to 21 µg/ in July 2007 and then back up to 187 µg/L in November. However, data from January 2008 showed concentrations back down to 65 µg/L. These wells are located immediately downgradient of well UVB-1, which was shut down in October 2005. These TVOC concentrations being 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 increase and then decline. These contaminants will be captured by the 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 2007, approximately 130 million gallons of groundwater were pumped and treated.

Operating Parameters

Water samples are obtained monthly from each of the seven extraction wells before air stripping in each UVB tray and after treatment. All 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

The following summarizes the system operations for 2007:

Well UVB-1 remained in standby mode throughout the year.

January – September 2007

The system was off from March 26 to April 5 for electrical repairs, and again from August 1 to August 8 for repairs to the blower. For the rest of this period the system operated although several wells were off for brief periods for repairs and/or routine maintenance.

October – December 2007

Well UVB-5 was off from October 1 to October 19, with electrical problems. The rest of the system operated normally for the remainder of the period. Well UVB-4 was put in standby in January 2007 as per last year's annual report recommendations.

3.2.6.5 System Operational Data

Recirculation Well Influent and Effluent

During 2007, influent TVOC concentrations in all treatment system wells remained stable, except for a significant drop in the concentrations in UVB-2 in the fourth quarter (**Figure 3.2.6-3**). The corresponding effluent well concentrations (**Figure 3.2.6-4**) showed decreasing or stable TVOC concentrations for the year. UVB-1 remained in standby mode for 2007. There was significant downtime for the system in 2007 due to electrical problems and routine maintenance and cleaning of the wells.

Overall for 2007, the average removal efficiency was 85 percent (**Table F-22**, **Appendix F**). Well UVB-1 was not used in this calculation because it was off, and well UVB-4 was not utilized because all of the influent concentrations were very low.

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-23** summarizes these data and they are included in **Appendix F**. Flow averaged approximately 41 gpm for the six operating wells during 2007. **Figure 3.2.6-5** plots the total pounds of TVOCs removed by the treatment system vs. time. During 2007, 43 pounds were removed from the aquifer, with a total of 1,010 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 changeout 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 564 cfm for the seven wells during 2007 (**Table F-24, Appendix F**).

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 2007.

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 2007, except for higher concentrations in wells 000-273 and -274, which is 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 in **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 approximately 12 years (2011). 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 2007. The overall reduction in the high-concentration areas of the plume near the south boundary is evident. This is an indication that concentrations of VOCs approaching the Industrial Park System will decrease over time.

The overall trend in the mean of the TVOC concentrations in the core groundwater monitoring wells is declining (**Figure 3.2.6-6**). 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 slightly decreasing trend.

4b. Is the mean TVOC concentration in core wells less than 50 µg/L?
No, the mean TVOC concentration in the plume core wells was ~ 100 µg/L.

4c. How many individual plume core wells are above 50 µg/L TVOC?
Three (000-259, -262, and -268) of the nine plume core wells have TVOC concentrations exceeding 50 µg/L, as of the fourth quarter 2007.

4d. During pulsed operation of the system, is there significant concentration rebound in the core wells?
No. The OU III Industrial Park In-Well Air Stripping System has not been pulsed to date.

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, 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 2008.
- The system will continue operations at 60 gpm per well except for well UVB-1, which is to remain in a standby mode. It is recommended that well UVB-4 be placed back in operation to address VOCs being observed in monitoring well 000-262, which is located between UVB-4 and UVB-5. Monthly recovery well sampling will continue, and if TVOC concentrations greater than 50 µg/L are observed, well UVB-1 will be restarted.

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3.2.7 Industrial Park East Pump and Treat System

This section summarizes the 2007 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.

3.2.7.1 System Description

The 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 EW I-1 is screened in the Upper Glacial Aquifer and EW I-2 is screened in the upper portion of the Magothy aquifer (see **Figure 3.2.6-1 and 3.2.3**). Extraction well EW I-1 is designed to operate at a maximum rate of approximately 120 gpm; extraction well EW I-2 is designed for approximately 100 gpm. In 2007, a new injection well was added to this system.

The treated water is recharged to the Upper Glacial aquifer through two recharge wells near the extraction wells, designated as DW I-1 and DW I-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 2004i).

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 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 is posted on **Figures 3.2.4-1, 3.2.6-1, and 3.2.7.1** . The complete results are in **Appendix C.** Results for key monitoring wells are as follows:

- Maximum TVOC concentrations during 2007 were found in downgradient well 000-495, at 16 μg/L during the fourth quarter, with TCA as the highest VOC, at 8.6 μg/L.
- In plume core well 000-514, about 100 feet west of the extraction wells, VOC concentrations were less then MCLs during 2007.
- VOCs in plume bypass wells 000-493, -494, have remained below the MCL since they were installed in June 2004. Concentrations in well 000-494 have shown VOCs below MCLs in 2007.
- Upgradient wells 122-24 and 122-25, which had shown concentrations as high as 570 μg/L in 2002, have been below 50 μg/L since August 2004. This correlates well with what has been observed in the area of the extraction wells, which is about 2 years' travel time from these wells.

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. All samples are analyzed for VOCs. In addition; the pH of the influent and effluent samples is measured monthly. Sampling for pH and VOCs adheres to the requirements of the SPDES equivalency permit. All effluent samples during this period of operation were within the permit levels (**Table 3.2.7-1**).

Table 3.2.7-1.
Industrial Park East Pump & Treat System
2007 SPDES Equivalency Permit Levels

Parameters	Permit Limit (µg/L)	Max. Measured Value (µg/L)
pH (range)	5.5–8.5 SU	5.6–6.6 SU
bromoform	50	<0.50
carbon tetrachloride	5	<0.50
chloroform	5	0.68
methylene chloride	5	0.79
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	1.1

Required sampling frequency is monthly for VOCs and pH.

System Operations

The following information summarizes the system operations for 2007.

January –September 2007

The system was off from February to the first half of April to install a new diffusion well. The system operated normally for the rest of this period. Forty-four million gallons were pumped and treated during the first three quarters of 2007.

October–December 2007

The system began pulse pumping of one month on and one month off in October. It was off for the month of November due to the system being pulse pumped. The system pumped and treated 17 million gallons of groundwater this quarter.

Extraction Wells Operational Data

During 2007, approximately 61 million gallons were pumped and treated by the IPE system, with an average flow rate of 120 gpm. The system began pulse pumping operations in November with a one month on and one month off. **Table F-25** shows the monthly pumping data for the system. VOC concentrations for the IPE extractions wells are provided in **Table F-27**. TVOC concentrations in EW I-1 ranged from 1.53 µg/L to 4.99 µg/L throughout 2007 and 6.6 µg/L to 22.08 µg/L in EW I-2.

3.2.7.5 System Operational Data

System Influent and Effluent

The overall TVOC influent concentrations to the carbon vessels were similar to levels that were recorded in 2006. **Tables F-27** and **F-28** in **Appendix F** 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 monthly pumpage rates for 2007 and gives total pounds of VOCs removed by the treatment system. **Figure 3.2.7-2** plots mass removal versus time. Approximately 4 pounds of VOCs were removed from the aquifer during 2007, and 32 pounds since system startup 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 MCLs in the Upper Glacial aquifer in 30 years (i.e., 2030) or less. According to the *OU III Explanation of Significant Differences* (BNL 2005b), MCLs within the Magothy aquifer must be met within 65 years (i.e., 2065) or less. The system will address the highest VOC concentration portion of the plume (above 50 µg/L).

The Industrial Park East Pump and Treat System performance during 2007 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 2007.

2.Has the plume been controlled?
Yes. The downgradient monitoring shows all concentrations below the capture goal of 50 µg/L of TVOCs. Contamination which has been detected in downgradient well 000-429 was present before the system began operations and this system was not designed to capture this.

3. Is the System operating as planned?
Yes. The system is operating as planned.

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 monitoring wells are below the capture goal of 50 µg/L for the treatment system.

4b. Is the mean TVOC concentration in core wells less than 50 µg/L (expected by 2025)?
Yes.

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 just started pulse pumping and no rebound has been observed to date.

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)?
No. MCLs have not been achieved for individual VOCs in all plume core wells. However, concentrations are very close to this level, with the highest concentration being 5.1 of TCA in well 122-24. MCLs are expected to be achieved by 2030 and 2065 for the Upper Glacial and Magothy aquifers, respectively, 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 pulse pumping for one year and if in November 2008 no rebound is seen (i.e., TVOC concentrations exceeding 50 µg/L) in extraction or monitoring wells, then petition for shutdown of this system.

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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 3.2-1**).

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 and satisfy the cleanup objectives defined in the OU III ROD (i.e., minimize plume growth and meet MCLs in the Upper Glacial aquifer by 2030).

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 2004f).

3.2.8.2 Groundwater Monitoring

Well Network

A network of 27 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/Animal Holes. Wells sampled under the OU III South Boundary and Industrial Park Programs are also utilized for mapping this plume.

Sampling Frequency and Analysis

The 27 wells are sampled and analyzed for VOCs according to the schedule in **Table 1-5**. Twenty-four wells are sampled and analyzed annually for gross alpha/beta, gamma spectroscopy, and Sr-90. All wells are sampled and analyzed annually for tritium.

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 3.2.8-5** depict the TVOC plume distribution and include data from the monitoring wells. The complete groundwater monitoring well data for 2007 are included in **Appendix C**. A north–south hydrogeologic cross section (H–H') of the plume is provided in **Figure 3.2.8-1.** The location for the cross section is shown in **Figure 3.2-1**. Monitoring well 000-154 had historically shown the highest VOC concentrations (primarily carbon tetrachloride) in the North Street area. TVOC concentrations greater than 1,000 µg/L were observed in 1997 and 1998, but have steadily declined since then to less than 6 µg/L in 2007. The trailing edge of the higher concentration segment of this plume has migrated south of this location. Plots of the VOC concentration trends in this area are shown in **Figure 3.2.8-2**.

VOC concentrations in wells 000-463 and 000-464, located about 200 feet north of NS-1, are still elevated (peak TVOC of 74 µg/L in 000-463 during 2007), but have been steadily declining, as shown in **Figure 3.2.8-2.** Well 000-472, adjacent to NS-2, has also steadily declined in the past 2 years, with a TVOC concentration ranging from 308 µg/L to 67 µg/L, observed in the second-quarter 2007 sample.

Several monitoring wells (800-63, 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. This suggests that 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.

Historically, tritium has been detected in localized off-site areas approximately within the area covered by the North Street VOC plume. Potential sources for this tritium are located in the Former Landfill/Chemical/Animal Holes and OU IV Building 650 areas of the site. Tritium has been detected in the deep Upper Glacial aquifer at concentrations well below the DWS of 20,000 pCi/L.

Historically, the highest tritium concentration was detected in 2001 in temporary well 000-337, at 9,130 pCi/L. This location is approximately 300 feet north of well 000-153. Tritium has been detected historically in well 000-153, but concentrations have decreased from 2,560 pCi/L in 2001 to <MDA in 2007. In 2007, tritium was not detected in any of the North Street monitoring program wells. This is consistent with the steady decline in tritium concentrations observed over the past several years. Radiological monitoring of North Street wells will continue in 2008.

3.2.8.4 System Operations

Bi-weekly laboratory analyses are performed on influent, midpoint, and effluent samples from the GAC units. All 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.

Table 3.2.8-1
OU III North Street
2007 SPDES Equivalency Permit Levels

Parameters	Permit Limit (µg/L)	Max. Observed Value (µg/L)
pH (range)	5.5 – 8.5 SU	5.9 - 7.5 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

ND = Not detected above method detection limit of 0.50 µg/L.

Required effluent sampling frequency is monthly for VOCs and pH.

January–September 2007

Routine operations continued from January through September, with approximately 139 million gallons pumped and treated during the first three quarters. The system was off periodically to allow for scheduled carbon filter changeouts. In addition, the system was off for the month of June to clean and replace float switches in the injection wells. Various power surges due to lightning strikes were experienced during the first three quarters, all of which required system restarts and repair.

October–December

Routine operations continued from October through December. The system was off periodically to allow for scheduled carbon changeouts. Approximately 47 million gallons were pumped and treated during this quarter.

3.2.8.5 System Operational Data

The system was operational from January to December 2007, with only minor shutdowns due to electrical outages, programmable logic controller (PLC) issues, scheduled maintenance, and GAC changeouts.

Extraction Wells

Table F-29 contains the monthly pumping data and mass removal data for the system. VOC concentrations for the extraction wells are provided in **Table F-30**. TVOC values in well NS-1 declined from 36 to 26 µg/L over the year, and well NS-2 remained unchanged, with TVOC values ranging from 16 to 20 µg/L. The decline in NS-1 TVOCs correlates to the concentrations in monitoring wells 000-463 and 000-464, located 200 feet upgradient of NS-1. There were no radionuclides detected in the extraction wells or in system influent in 2007.

System Influent and Effluent

VOC concentrations in 2007 for the NS carbon influent and effluent are summarized in **Tables F-31** and **F-32**. The combined influent TVOC concentration declined from 75 µg/L in December 2004 to 15 µg/L in December 2007.

The carbon vessels for the system effectively removed all contaminants from the influent groundwater. All effluent data were below the analytical method's detection limit.

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 3.2.8-3**. During 2007, approximately 139 million gallons of groundwater were pumped and treated by the North Street system, and approximately 36 pounds of VOCs were removed. Since May 2004, the system has removed 268 pounds of VOCs. The mass removal data are summarized in **Table F-29.**

3.2.8.6 System Evaluation

Figure 3.2.8-4 compares the TVOC plume from 1997 to 2007. The following significant changes were observed in the plume over this period:

- The trailing edge of the plume has migrated south of the BNL site.
- TVOC concentrations in monitoring wells 200 feet upgradient of NS-1 are showing a steady decline.
- TVOCs in wells downgradient of NS-1 and NS-2 are increasing, as this plume segment that was south of the North Street system prior to start-up migrates toward the Airport.

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 2007.

2. Has the plume been controlled?

Yes. The cleanup goals have not been met; however, it must be verified that the plume is not growing. An analysis of the plume perimeter and bypass wells shows that there have been no significant increases in VOC concentrations in 2007; thus, it can be concluded that that plume has not grown and continues to be controlled. It should be noted that a segment of the plume now located between Crestwood Drive north to Waldorf Drive was beyond the capture zone of the North Street extraction wells at the time of system start-up. This portion of the plume will be addressed by the Airport extraction wells directly downgradient.

The leading edge of the plume was defined at Flower Hill Drive at concentrations below the NYS AWQS for individual VOCs. The Airport Pump and Treat System is designed to capture any contaminants migrating south of Flower Hill Drive.

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 3 years of operation, the system influent VOC concentrations have been slightly higher than originally projected in the final design. 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. During 2007 there were no detections of radionuclides in the monitoring wells.

5. Can the groundwater treatment system be shut down?
No, the system has not met all shutdown requirements.

5a. Have asymptotic TVOC concentrations been reached in core wells?
No. Asymptotic conditions have not yet been achieved.

5b. Are there individual plume core wells above 50 µg/L TVOC ?
Currently five of 12 plume core wells are showing concentrations greater than 50 µg/L TVOC.

5c. During pulsed operation of the system, is there significant concentration rebound in the core wells?
The North Street System has not been pulsed to date.

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 the 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 initiated in 2006.
- Eliminate the Sr-90, gamma spectroscopy, and gross alpha/beta analysis for monitoring well samples due to the absence of any detections for radionuclides over the past several years.

3.2.9 North Street East Pump and Treat System

This section summarizes the 2007 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 Treatment System consists of two extraction wells pumped through two 20,000-gallon GAC units and discharged to injection wells. Both the North Street and North Street East systems are located in the same building and discharge the treated water to four injection wells located on North Street. Extraction well NSE-1 is designed to operate at a rate of approximately 200 gpm; extraction well 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 2004f).

3.2.9.2 Groundwater Monitoring

The monitoring network consists of 15 wells. 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 (**Figure 1-2**). During 2007, the wells were sampled at the O&M phase frequency (core and perimeter wells sampled semi-annually, and sentinel wells sampled quarterly). However, as recommended in the 2006 Groundwater Status Report, plume core wells 000-482, 000-483, and 000-484 maintained the quarterly sampling frequency since they are immediately upgradient of extraction well NSE-2. Well 000-481 should have also been changed to the quarterly frequency. This change will take place in 2008. The wells are also sampled at least annually for tritium, Sr-90, and gamma spectroscopy. Eleven of the 15 wells are also sampled annually for gross alpha/beta. See **Table 1-5** for details.

3.2.9.3 Monitoring Well Results

Figure 3.1-1 shows the extent of the VOC plume. The plume originated from the Current Landfill and former HWMF (sources in OU I). The on-site segment of the plume is being treated by the OU I South Boundary Remediation System. The off-site segment of the plume, located south of BNL, is being addressed by the NSE Remediation System. This segment of the plume extends from the vicinity of North Street to south of the LIPA right of way, a distance of approximately 3,400 feet. The maximum width of this segment of the plume is approximately 450 feet. The higher concentration segments of the plume (the 10 μg/L TVOC contour) are just north of the LIPA right of way and extraction well NSE-1, and just north of NSE-2.

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 in **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 2007 analytical results for the 15 NSE program wells. A summary of key monitoring well data for 2007 follows:

- The plume continues to be bounded by the current network of wells.
- All monitoring wells in the plume have remained below the treatment system capture goal of 50 μg/L TVOCs in 2005, 2006, and 2007, except for one detection in well 000-478 of 58 μg/L, in March 2005.

- The maximum plume TVOC concentration observed in 2007 was 36 µg/L in plume core well 000-478. The primary compound identified in the sample was chloroform, at 26 µg/L. This well is located in the center-line of the plume just upgradient of NSE-1. The 2007 VOCs in this well are consistent with the last two years of data. When the well was installed in 2004, TVOCs were as high as 205 µg/L. Plume core well, 000-477, located slightly west of 000-478, has remained consistent over the past 2 years, with TVOC concentrations less than 20 µg/L.
- TVOC concentrations in core wells 000-479 and 000-480 were as high as 77 µg/L in 2004, but have dropped to less than 5 µg/L since mid 2005. These wells are upgradient of NSE-1.
- TVOC concentrations in plume perimeter well 000-137 remained very low, with detections since 2002 of below 5 µg/L. This signifies that the trailing edge of the shallower lobe of this plume has migrated south of North Street (**Figure 3.1-2**). Concentrations in core well 000-138 have dropped from 253 µg/L in 1999 to less than 50 µg/L since 2000. In 2007, the TVOCs dropped further to less than 5 µg/L.
- The maximum TVOC concentration in plume core well 000-124 was less than 5 µg/L in 2007, down from a high of 489 µg/L in 1998.
- Following an increase in TVOC concentrations in 2005 and 2006, plume core well 000-481, located between NSE-1 and NSE-2, has dropped back to less than 5 µg/L in 2007. In addition, nearby core wells 000-482, 000-483, 000-484, and 000-485 have remained less than 5 µg/L since 2005.
- The highest tritium concentration in the plume in 2007 was detected at 520 pCi/L in well 000-215. There have been no detections of tritium greater than 1,000 pCi/L in any of the wells since 2005. In addition, historically there have not been any detections of Sr-90 in any of the monitoring wells.

3.2.9.4 System Operations

Influent, midpoint, and effluent samples from the GAC units are sampled monthly, per SPDES Equivalency Permit requirements. The extraction wells were also sampled monthly, except for July and December 2007. All samples are analyzed for VOCs. In addition, the influent and effluent samples are analyzed monthly for pH. The system effluent is also analyzed for tritium. **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
2007 SPDES Equivalency Permit Levels

Parameters	Permit Limit (µg/L)	Max. Observed Value (µg/L)
pH range	5.5–8.5 SU	5.6– 6.4 SU
carbon tetrachloride	5	ND
chloroform	5	1.9
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

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 NSE system operated from January through December 2007. The system was operational throughout the year with only minor shutdowns due to electrical outages, programmable logic controller (PLC) issues, and scheduled maintenance. During 2007, approximately 4 pounds of VOCs were removed. Since October 2006 the system was pulse pumped with the system on one month and off the next.

January through September

The system was down for two months in June and July due to electrical surges and injection well maintenance. The system pumped and treated approximately 58 million gallons of water.

October through December

The system operated normally for the last quarter of 2007. The system was on in October and November and off in December per the pulse pumping schedule. In this quarter, the system pumped and treated approximately 13 million gallons of water.

Extraction Wells

During 2007, 71 million gallons were pumped and treated by the NSE system; **Table 2-3** contains the monthly pumping data for the two extraction wells. VOC concentrations for NSE-1 (000-487) and NSE-2 (000-483) are provided in **Table F-33** in **Appendix F**. Declining TVOC trends are noted for both wells during 2007, with concentrations below 10 µg/L reported in both wells during the entire year.

System Influent and Effluent

VOC concentrations for 2007 for the carbon treatment influent and effluent are summarized in **Tables F-34** and **F-35.** Influent TVOC concentrations have been at or below 10 µg/L since 2005. The carbon treatment system effectively removed VOCs from the influent groundwater. All effluent concentrations were 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

The mass of VOCs removed from the aquifer by the NSE Treatment System was calculated. Average flow rates for each monthly monitoring period were used, in combination with the VOC concentration in the system influent, to calculate the rate of contaminant removal (**Table F-36**). The cumulative mass of VOCs removed by the treatment system versus time was then plotted (**Figure 3.2.9-1**). It shows that 4 pounds of VOCs were removed during 2007, with a cumulative total of 19 pounds of VOCs removed since system startup in April 2004.

3.2.9.6 System Evaluation

The system began operations in June 2004 and was planned 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 Treatment System.

2. Has the plume been controlled?
Yes. The system has been in operation for three years, and an analysis of the plume perimeter and bypass wells shows that there have been no significant increases in VOC concentrations in 2007, thus we conclude that 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 modeled in the system design, and the system has been removing VOCs from the deep Upper Glacial aquifer. However, system influent VOC concentrations have been less than originally projected. In addition, the monitoring wells have shown low concentrations following initial startup of the system. Indications are that the system may not need to operate as long as originally planned.

4. Can the groundwater treatment system be shut down?

No. Even though 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, one well, 000-478, is under the 50 µg/L criteria and should be captured by the system.

4a. Have asymptotic TVOC concentrations been reached in core wells?
No. Since the system has only been operating for just over three years, sufficient time has not yet been realized to reach an asymptotic condition. These conditions may be achieved in the next couple of years.

4b. Are there individual plume core wells above 50 µg/L TVOC ?
No. All core wells were below 50 µg/L TVOCs.

4c. During pulsed operation of the system, is there significant concentration rebound in core wells?
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. Wells 000-477 and 000-478 identified TCA and chloroform above MCLs. However, MCLs are expected to be achieved by 2030.

3.2.9.7 Recommendations

The following recommendations are made for the NSE Pump and Treat System and groundwater monitoring program:

- Maintain the routine operations and maintenance monitoring frequency for the monitoring wells that began in third quarter 2006. However, plume core wells 000-481, 000-482, 000-483, and 000-484 should be maintained at the quarterly sampling frequency since they are immediately upgradient of extraction well NSE-2.

- Delete Sr-90, gross alpha/beta, and gamma spectroscopy from the analyte, list since there have been no detections above the standards.
- Continue pulse pumping of both extraction wells, since the system influent concentrations have remained very low over the past two years and all of the monitoring wells are already below the capture goal of 50 µg/L TVOC. The pulse pumping consists of having the system on for one month, then off in standby mode for the next month. The extraction well sampling frequency will change from a monthly schedule to only sample during the months the system is in operation (every other month) If concentrations above the capture goal of 50 µg/L TVOCs are observed in either the core monitoring wells or the extraction wells, the well(s) will be put back into full-time operation. If no rebound is observed in 2008, then petition for shutdown of the system.
- As of the first quarter 2008, lower the pump location four feet in monitor wells 000-482, 000-483, and 000-484 to obtain data from a slightly deeper portion of the aquifer.

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3.2.10 LIPA/Airport Pump and Treat System

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 (see **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 TVOC.
2. The three LIPA extraction wells (EW-1L, -2L, and -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. The six extraction wells in the Airport System were installed to address the leading edge of the plumes, which have migrated past the LIPA extraction wells and the North Street extraction wells. The sixth well was added in 2007 to address concentrations of VOCs observed to the west of extraction well RTW-1A. The Airport system wells were installed to prevent further migration of the plumes. They 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 -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 2004g).

3.2.10.2 Groundwater Monitoring

Well Network

The monitoring network consists of 50 wells. There are 16 wells associated with the LIPA Upper Glacial portion of the plume and was designed to monitor the VOC plume off site, south of the OU III Industrial Park System. The Airport System network has 28 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** identifies the monitoring wells for these plumes.

Sampling Frequency and Analysis

The monitoring wells for LIPA are currently on a quarterly and semi-annual schedule for VOCs. The Airport wells are quarterly.

3.2.10.3 Monitoring 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 2007 well data is posted on **Figures 3.2-1** and **3.2.10-2**. The complete results are in **Appendix C** and **Table F-38** in Appendix F summarizes the data for the extraction wells. Results for key monitoring wells and extraction wells are as follows.

- Maximum TVOC concentrations during 2007 for the Magothy extraction well EW-4L on Stratler Drive ranged from 76 µg/L in January to 47 µg/L in December 2007. Carbon tetrachloride is the primary VOC detected in this well. All of the Magothy monitoring wells associated with this portion of the plume show concentrations below 50 µg/L TVOC, with well 000-130 showing the highest concentration, at 39 µg/L in May 2007. Figure 3.2.10.3 has the LIPA trend plots for the extraction wells.

- Two of the three Upper Glacial LIPA extraction wells, EW-1L and EW-3L were shutdown in October 2007 as per recommendations in last years annual report. Well EW-2L had a high concentration of TVOCs of 38 µg/L in January and a low of 22 µg/L in December 2007. Wells EW-1L and EW-3L continued to show VOC concentrations less then MCLs except for one detection of TCE in well EW-1L at 7 µg/L in October 2007.
- All monitoring wells near the extraction wells for the airport system are below MCLs except for well 800-96. However, upgradient monitoring wells 800-94 and -95, approximately 1,500 feet north of wells RTW-1A and -2A, have historically shown TVOC concentrations primarily composed of carbon tetrachloride ranging up to 100 µg/L. This is an indication that higher concentrations should be expected at the extraction wells. Five of the six airport extraction wells had VOC concentrations below MCLs throughout 2007. Newly installed extraction well RTW-6A showed concentrations as high as 86 µg/L in November during startup and concentrations had dropped to 12 µg/l in December.
- Well 800-96 is screened from 180 to 200 feet below grade. The well 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 a concentration of carbon tetrachloride of 10 µg/L was detected in this well, and on August 31, 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. Subsequent sampling showed concentrations of 100 µg/L in November 2006, 60 µg/L in December, and 51 µg/L in January 2007, with a maximum concentration of 122 µg/L in December 2007. During 2007 a new extraction well RTW-6A and five new monitoring wells (800-126, 800-127, 800-128, 800-129, 800-130) were installed to monitor and capture the contaminants in well 800-96. See Figure 3.2.10.1 for locations. In addition, downgradient monitoring well 800-107, located several hundred feet south of extraction wells RTW-1A, had to be abandoned due to construction activities at Dowling College and was replaced with well 800-131, located just south of the original well.

3.2.10.4 System Operations

The extraction wells were sampled once per month in 2007. The influent, midpoint, and effluent of the carbon units were sampled once per week, along with weekly pH readings. All samples were analyzed for VOCs. The Airport extraction wells are being pulsed pumped one week per month except well RTW-1A and RTW-6A which are on a full time basis.

The following is a summary of the OU III Airport/LIPA operations for 2007.

January–September

The system operated normally during this period, with some down time other than for routine maintenance and repairs. The Airport System was down in August and September while a new extraction well (RTW-6) was installed and tied into the system. At this time additional controls were installed in the system to allow for the operation of the new extraction well. The Airport wells continued a pulse pumping schedule of one week of operation per month except for well RTW-1A, which operated on a full time basis.

October–December

The system was off for the last part of October and the entire month of November due to construction work. These problems were cleared up in December. New Extraction well RTW-6A began full time operations at this time.

Extraction Wells Operational Data

During 2007, approximately 171 million gallons were pumped and treated by the OU III Airport/LIPA System, with an average flow rate of 498 gpm. **Table F-37** shows the pumping data. VOC concentrations for the airport and LIPA extractions wells are provided in **Table F-38**. VOC levels in all airport extraction wells were below MCLs, except for well RTW-6A. **Table 3.2.10-1** below shows maximum measured values and the values allowed under the SPDES equivalency permit.

3.2.10.5 System Operational Data

System Influent and Effluent

VOC concentrations in 2007 for the carbon influent and effluent are summarized in **Tables F-39** and **F-40**.

The carbon vessels for the system effectively removed all contaminants from the influent groundwater. All effluent data were below the analytical method detection limit and below the regulatory limit specified in the SPDES equivalency permit.

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**) shows that 35 pounds of VOCs were removed during 2007, with a total of 237 pounds removed since startup.

Extraction Wells Data Evaluation

Table F-38 in **Appendix F** summarizes the data for the extraction wells.

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. However, to date no concentrations of VOCs above MCLs have been detected in the original five extraction wells. The newly installed extraction well (RTW-6A) has shown carbon tetrachloride above MCLs 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.

The OU III Airport/LIPA system performance can be evaluated based on the five major decision rules identified for this system resulting from the groundwater DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?

No, however the Plan was triggered in 2006. This was due to the concentrations of VOCs observed in well 800-96, which is outside the capture zone of the treatment system. No unexpected VOC concentrations were observed in the monitoring wells of the LIPA/Airport Treatment System during 2007.

Table 3.2.10-1
OU III LIPA/Airport Pump & Treat System
2007 SPDES Equivalency Permit Levels

Parameters	Permit Level (µg/L)	Max. Measured Value (µg/L)
pH	5.5–7.5 SU	5.7-7.4 SU
carbon tetrachloride	5	ND
chloroform	7	ND
1,1-dichloroethane	5	ND
1,1-dichloroethylene	5	ND
methylene chloride	5	ND
1,1,1-trichloroethane	5	ND
trichloroethylene	10	ND

ND = Not detected above method detection limit of 0.50 µg/L.

2. Has the plume been controlled?

Based on the results of the *LIPA/Airport Pump Test Report* (Holzmacher 2004), the plumes are being controlled. The capture zones 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. An additional extraction well was added and five additional monitoring wells to ensure its capture. This work was completed in November 2007.

3. Is the system operating as planned? Specifically, is the aquifer being restored at the planned rate?

Yes, the system is operating as planned. These wells have not been operating long enough to evaluate the progress of aquifer restoration.

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 met.

4b. Is the TVOC concentration in the LIPA core wells less than 50 µg/L)?

Yes; however, extraction well EW-4L still shows concentrations greater then 50 µg/L during some of the months of operation. Since access in this area is limited the extraction well data is utilized to help in tracking the plume.

4c. Are the TVOC concentrations in the Airport core wells less than 10 µg/L ?

No, six airport core wells (800-63, -94, -95, -96, -99 and -106) have TVOC concentrations greater than 10 µg/L.

4d. During pulsed operation of the system, is there significant concentration rebound in core wells?

The intent of the current pulse pumping is not to evaluate for rebound but to reduce pumping while the high-concentration segment 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 2070, 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:

- The extraction well sampling will be reduced from monthly to quarterly, except for the LIPA well EW-4L and Airport wells RTW-1A and 6A.
- Continue the airport extraction wells pulse-pumping of one week per month except for wells RTW-1A and 6A, which will continue with full-time operations. Pump well RTW-3A full time to intercept any VOCs migrating from the area of upgradient wells 800-99 and 800-106. If concentrations above the capture goal of 10 µg/L TVOCs are observed in any of the other 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 in either the plume core monitoring wells or the extraction wells, greater than the 50 µg/L capture goal.
- Change well 800-96 from monthly to a quarterly sampling schedule since the new extraction well, EW-6A, is in operation.
- Install a temporary well 200 feet to the west of well RTW-3A and follow up with permanent monitoring well(s). This will be done to confirm the location of the western edge of the plume currently seen in upgradient monitoring wells 800-90 and 800-92.

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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 data 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, Industrial Park East, and Central Monitoring. A brief summary of the results is provided in **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 2007).

	Max. TVOC in µg/L			
Location	2007	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	117	340	PCE, CCl4	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	48	50	TCE	Low 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	8	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	59	570	TCA, CCl4	TVOCs currently less then 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	39	7,200	CCl4	Historically high VOC concentrations just south of Carleton Drive where brown clay is absent. Levels of TVOCs are now less then 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, Airport, Industrial Park East, and LIPA)

2. Data from the monitoring wells will continue to be evaluated 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 5-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 onsite 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.
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. 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 VOCs have ranged from 31 to 39 µg/L in 2007. 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 & Treat System.

Wells 000-249 and -250: These wells are in the Industrial Park near well UVB-1. Well 000-249 had VOC concentrations ranging from 59 µg/L in May 2007 to a low of 24 µg/L in November. Well 000-250 had VOC concentrations below MCLs in 2007. 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 of this system will be captured by the Stratler Drive extraction well.

Wells 000-425 and -460: These wells are adjacent to the LIPA Stratler Drive Magothy extraction well. Well 000-425 had concentrations of VOCs ranging from 10 to 26 µg/L during 2007. 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 of 26 µg/L in November 2007. The other three sampling events were below MCLs.

Well 122-05: located at the eastern edge of the OU III South Boundary System, showed concentrations of VOCs ranging from 19 to 25 µg/L in 2007.

Well 000-343: south and between the OU I and OU III South Boundary systems, had VOC concentrations between 6 and 10 µg/L in 2006.

Well 115-50: located south and between the OU I and OU III South Boundary systems, had concentrations up to 4 µg/L in 2007.

Wells 000-427 and -429: are just south of the Industrial Park East system on Carleton Drive. Well 000-427 had concentrations ranging from 4 to 14 µg/L in 2007. Well 00-429 had concentrations ranging from <1 µg/L in January, to 59 µg/L in November.

Well 800-90: this well has historically not shown contaminants above MCLs. However, the sample in December shows TVOCs at 48 µg/L. It is screened at about 255 feet below grade. This well is co-located with Well 800-92.

Well 800-92 (not a Magothy well), (~200 feet) located about 2,500 feet north of the airport system, had VOC concentrations ranging from 43 to 50 µg/L in 2007. The chemicals in both wells are similar. 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.

3.2.11.2 Recommendations

Continue the current monitoring schedule for the Magothy monitoring program (see **Table 1-5**).

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3.2.12 Central Monitoring

The OU III 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 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, which are located near the BNL western site boundary. They were installed by the Suffolk County Department of Health Services (SCDHS) to serve as sentinel wells for the Suffolk County Water Authority (SCWA) William Floyd Parkway well field.

3.2.12.1 Groundwater Monitoring

Well Network
The monitoring well network is comprised of 20 wells (**Figure 1-2**). The locations aid in defining the VOC plumes, which extend downgradient from the central areas of the site. This network also is supplemented by data from Environmental Surveillance (ES) program wells that monitor active research and support facilities (**Table 1-6**). Results from the 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 gamma spectroscopy, tritium, and Sr-90 (**Table 1-5**). Select ES wells in the AGS Complex are typically sampled annually for VOCs in order to complete the northern portion of the OU III VOC plume configuration.

3.2.12.2 Monitoring Well Results

VOC concentrations detected in most of the OU III Central wells are near or below NYS AWQS. The primary constituent in many of the wells in the north-central developed portion of the site is TCA. A discussion of some of the key wells follows.

- Wells 083-01 and 083-02 are near the intersection of Brookhaven Avenue and Upton Road, and are screened in the Upper Glacial aquifer. These wells consistently have contained 1 to 8 µg/L and 10 to 25 µg/L of chloroform since 1997, respectively. In November 2007, well 083-01 had a detection of chloroform of 7.8 µg/L, barely exceeding the NYS AWQS of 7.0 µg/L. Sources of this contamination may be in the water treatment plant chlorination process.
- 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 have been no detections of VOCs in either well since early 2003, with the exception of chloroform and methylene chloride at concentrations less than 1 µg/L (the detection limit is 0.5 µg/L) and one detection of trace levels of toluene in well 109-04 in March 2007. No radionuclides were detected in either well in 2007.
- Well 065-02, located near the AGS complex, had a detection of TCA at 17 µg/L in November 2007. This is consistent with historic results.

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 during 2007?
No. There were no unusual or unexpected VOC or radionuclide concentrations in the monitoring wells associated with this program during 2007.

2. Are there potential impacts to the SCWA William Floyd Parkway well field from on-site contamination?
No. There were no detections of contaminants in the sentinel monitoring wells during 2007, with the exception of low-level chloroform detections (below NYS AWQS).

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, several individual wells continued to contain VOC concentrations exceeding the NYS AWQS during 2007; therefore, the OU III ROD objective of meeting MCLs by 2030 has not 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 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 for the southwest portion of the OU III plume or 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**). Some wells downgradient of the leading edge of the plumes serve as sentinel wells. Their locations and screen depth, in the deep portions of the Upper Glacial aquifer.

Sampling Frequency and Analysis

The wells were sampled semiannually, and samples are analyzed for VOCs (**Table 1-5**). As per the 2006 *Groundwater Status Report* recommendations, the sampling frequency for this program will be changed to annually in 2008. Samples are to be collected in the fourth quarter of each year.

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 in **Figure 3.2-1**.

The monitoring wells in the OU III Off-Site Program are perimeter and sentinel wells. They continue to have VOC concentrations below the NYS AWQS.

3.2.13.3 Groundwater Monitoring Program Evaluation

There were no unexpected results during 2007 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 monitoring program are warranted at this time.

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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 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, OU VI, and OU V STP groundwater monitoring programs.

3.2.14.1 Groundwater Monitoring

A network of 59 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 in **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 2007. In April 2007 there were several reported low-level detections of radionuclides within the South Boundary Radionuclide Monitoring Program. A data usability review indicates that these results are most likely false positives. Therefore, the analytic results have been flagged to indicate this conclusion.

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 2007 to trigger the BNL Groundwater Contingency Plan.

3.2.14.4 Recommendations

No changes are recommended for the OU III South Boundary Radionuclide Monitoring Program. The wells will continue to be sampled on an annual basis for radionuclides.

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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 as part of the OU III AOC 29 HFBR and Building 801 programs (see **Sections 3.2.17** and **4.11**). These wells are sampled concurrently for all programs to avoid duplication of effort. The BGRR/WCF remedy consists of:

1. Installation of five extraction wells using ion exchange to remove Sr-90, with on-site discharge of the clean water to injection wells
2. Operation of the system to minimize plume growth and meet DWS within 70 years (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 from the WCF area, one in an area south of the BGRR Below Ground Ducts (BGD) and 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

Construction of the Sr-90 BGRR/WCF groundwater treatment system was completed in December 2004. Startup testing for the new treatment system began in January of 2005. The *Sr-90 BGRR/WCF/PFS Groundwater Treatment System Start-Up Report* (BNL 2005d) was finalized in April 2005, and full operation of the treatment system began in July 2005. There are two extraction wells (SR-1 and SR-2) south of the WCF and three extraction wells (SR-3, SR-4, and SR-5) south of the BGRR. The treatment system typically operates at an average rate of 25 gpm total from five extraction wells.

Groundwater from the five extraction wells is transported through pipelines to an ion exchange treatment system inside Building 855. 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 VOCs using liquid phase activated carbon.

Effluent is recharged to the Upper Glacial aquifer via three drywells approximately 850 feet west of Building 855. A New York SPDES equivalency permit regulates this discharge. A complete description of the system is included in the *Operation and Maintenance Manual for the Sr-90 BGRR/WCF/PFS Groundwater Treatment System* (BNL 2005e).

3.2.15.2 Groundwater Monitoring

Well Network

A network of 86 monitoring wells monitor the Sr-90 plumes associated with the BGRR, WCF, and PFS areas. In late 2005, six monitoring wells (085-299, -300, -302, -310, -311, and -312) in the network were abandoned due to construction of the new Center for Functional Nanomaterials (CFN). Five new wells were installed in the fall of 2007 to replace the abandoned wells and enhance plume monitoring (BGRR07-A, through E). Two new monitoring wells (065-384 and -385), located just south of the WCF and downgradient of the g-2 area (**Figures 1-2 and 3.2.1 5-1**), were installed in January 2006 after tritium from the g-2 plume was captured by extraction well SR-2.

Sampling Frequency and Analysis

Through 2007, the monitoring well sampling frequency remained at the startup phase (semi-annual). The well samples are analyzed for Sr-90. As noted in **Table 1-5,** wells also serve duel purposes for other programs.

3.2.15.3 Monitoring Well/Temporary Well Data

The Sr-90 plume distribution map is shown in **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 2007 sampling of the monitoring well network and temporary wells.

Historically, the highest Sr-90 concentration (3,150 pCi/L) was collected in 2003 from 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) was in April 2003, from a temporary well installed immediately downgradient of the six former underground storage tanks (USTs A/B), 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) was collected in March 1997 from a temporary well installed downgradient of the PFS.

The following is a summary of the 2007 monitoring well data for the three Sr-90 plumes:

WCF Plume (refer to **Figure 3.2.15-4** for cross-sectional view of plume):

- In 2007, the highest Sr-90 monitoring well concentration from all three plumes was 302 pCi/L during October from plume core well 065-175, which is immediately south of the WCF yard. This is a decrease from the 2006 high of 801 pCi/L in the same well. The historical high for this well was 821 pCi/L in 2000. **Figure 3.2.15-5** shows a gradually declining trend in this well since 1999. This contamination will be captured by extraction well SR-2.
- Plume perimeter well 075-662, previously located on the western portion of the plume just downgradient of the HFBR stack, was abandoned in August 2007 due to an obstruction in the well. The previous high for this well was 41 pCi/L in 2006. A replacement well, BGRR07-A, was installed in late 2007. Sr-90 was detected below the DWS in the December sample.
- Wells 075-47, -48, and -87, located on Temple Place, are sentinel wells for the WCF Sr-90 plume. In well 075-48, the maximum Sr-90 detection was 0.5 pCi/L for 2007. An additional sentinel well, BGRR07-E, was installed in late 2007 at this location. There was no Sr-90 detected.
- Sentinel wells 065-384 and 065-385 were installed in January 2006 to monitor the g-2 tritium plume concentrations immediately upgradient of SR-2. The highest tritium concentrations in these wells in 2007 was 11,700 pCi/L in October from well 065-384, and 2,850 pCi/L from well 065-385 in March. This is a significant reduction in tritium concentrations since the 150,000 pCi/L was identified in a temporary well at this location in January 2006. To maintain groundwater flow so as not to adversely affect the position of the g-2 tritium plume, the optimum pumping ratio between the western and eastern supply well field has been maintained at the goal of 75 to 25 percent split. During 2007, the western well field provided approximately 90 percent of the total water pumpage.

As recommended in the 2006 *Groundwater Status Report*, starting in June 2007 select wells were analyzed for Sr-90 during the installation of temporary wells just northwest of the HFBR as part of the characterization effort for the downgradient portion of the g-2 Tritium Plume. The two plumes are in close proximity in this area, which allowed for a number of data points to be collected to supplement the existing Sr-90 monitoring well network. Four sets of east-west temporary well transects were installed from June 2007 through March 2008. The 22 temporary well locations (i.e., g-2-GP-62) are identified on **Figure 3.2.15-1** and the complete data set is available in **Table 3.2.15-2**. The transects are located as follows:

- A – The northern-most transect situated in the parking lot just south of Rutherford Drive to the east of the BGRR
- B – Approximately 175 feet south of transect A and 250 feet north of the HFBR.

- C – Immediately north of the HFBR
- D – The southern-most transect just south of the HFBR.

The following is a brief summary of the data for the four transects:

- Transect A – The data from the four temporary wells installed in August/September 2007 is consistent with the previous monitoring well data in this area. The maximum Sr-90 concentration was in temporary well g-2-GP-79 at 52 pCi/L. The eastern-most temporary well detected 40 pCi/L of Sr-90.
- Transect B – Four temporary wells installed identified Sr-90 concentrations higher than was anticipated for this area. The maximum detection was 294 pCi/L in g-2-GP-72. The elevated concentrations (~200 pCi/L) were consistently identified in all four temporary wells. The width of the 100 pCi/L isocontour in this area is significantly wider than previously determined based on the existing monitoring wells and the pre-design groundwater characterization efforts.
- Transect C – Six temporary wells were installed at this transect between October and December 2007, with the seventh (g-2-GP-68) in March 2008. The previous understanding of the plume in this general area was that Sr-90 concentrations were less than 100 pCi/L. It should be noted that no permanent monitoring wells exist in this area to monitor the center-line of the plume. Well 065-39, located approximately 300 feet northwest of the HFBR building, monitors the eastern edge of the plume. The maximum 2007 Sr-90 concentration at this location was 518 pCi/L in temporary well g-2-GP-63. This concentration was significantly higher than expected and prompted the BNL Groundwater Contingency Plan to be implemented (see **Section 3.2.15.6**). The adjacent temporary well to the east, g-2-GP-64, had 271 pCi/L of Sr-90. The width of the 100 pCi/L isocontour in this area is greater than 300 feet. Based on the significantly higher Sr-90 concentrations recently detected in this area, without active treatment the plume is not expected to naturally attenuate to below the drinking water standards within the required timeframe of 70 years as defined by the OU III ROD and ESD (see **Section 3.2.15.6** for further discussion).
- Transect D – The data from the seven temporary wells installed in February/March 2008 in front of the HFBR building shows that the leading edge of the plume is slightly south of this area. The maximum Sr-90 detected in this southernmost transect is 83 pCi/L, in westernmost temporary well g-2-GP-93. The remaining temporary wells to the east did not detect Sr-90 above 28 pCi/L. Sentinel monitoring wells on Temple Place only detected trace amounts of Sr-90.

BGRR Plume:

- The highest Sr-90 concentration downgradient of the BGRR in 2007 was from extraction well SR-3, reaching a peak of 1,650 pCi/L in September. This is the historical high concentration for this well since its installation in 2005.
- Plume core well 075-664 is the closest upgradient well to SR-3, approximately 45 feet away. The highest concentration of Sr-90 detected in this well was 76 pCi/L in March 2007. As depicted on **Figure 3.2.15-2**, this well appears to be screened a few feet below the high area of Sr-90 contamination seen in SR-3.
- The highest Sr-90 concentration in a monitoring well downgradient of the BGRR: in 2007, 148 pCi/L in plume core well 075-669. **Note**: This value is not identified on **Figure 3.2.15-1** since it was obtained in the second quarter.) This value is slightly less than the 2006 value in this well, 234 pCi/L. This well, located south of Cornell Avenue, is approximately 200 feet downgradient of the southernmost extraction well, SR-4. This portion of the plume is not being actively remediated. Based on the monitoring data to date, it is expected to naturally attenuate on site to below the drinking water standards within 70 years.

- Plume core wells 075-666 and 075-673 are immediately upgradient of extraction well SR-5. The concentrations in these wells, up to 9 pCi/L in both wells in 2007, are less than the detections in 2005 and 2006.
- Plume perimeter wells 075-195, -196, -197, and -200, located west of the downgradient portion of the plume, are all less than the DWS.
- Sentinel wells, 075-670 and -671 are north of Brookhaven Avenue on the National Synchrotron Light Source (NSLS) lawn. Prior to 2007, these wells were located just downgradient of the leading edge of the plume. In 2007, both wells detected Sr-90 above the DWS, between 12 pCi/L and 14 pCi/L.

Pile Fan Sump Plume:

- The highest Sr-90 concentration in the PFS plume is in core well 075-85, located just south of Cornell Avenue This well reached a high of 76 pCi/L in October 2007. The previous high was 25 pCi/L, in 2002. This plume is not addressed by active pumping, but will naturally attenuate to below the DWS.
- Plume perimeter wells 075-46, 075-86, and 075-672 were previously located just downgradient of the leading edge of the plume. 2007 data from these wells were below the DWS. The highest 2007 Sr-90 concentration in these wells was 5.4 pCi/L in well 075-86, in October.
- A new monitoring well, BGRR07-D, is located on the eastern downgradient perimeter of the plume. The Sr-90 detection in December 2007 was 30 pCi/L.
- Plume core wells 075-193, -194, -674, and -675 are located on the south side of Cornell Avenue and monitor the western portion of the leading edge of the plume. The highest 2007 Sr-90 concentration in these wells was 19 pCi/L, in well 075-675 in April.
- Plume perimeter well 065-37, located just downgradient of the PFS, detected up to 74 pCi/L in October 2007. As noted on **Figure 3.2.15-5**, this is a significant increase from the last seven years of data. See Section 4.11 for further discussion.

During 2007, TVOC concentrations for the monitoring wells were below 5 µg/L, except for well 075-10 in October. This perimeter well for the BGRR plume detected 7 µg/L TVOCs, with chloroform at 2.4 µg/L and TCA at 1.9 µg/L, both below the DWS.

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 – North–south cross section from Building 801 south to Cornell Avenue
- **Figure 3.2.15-4** (K–K') for the WCF plume – 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**.

3.2.15.4 System Operations

The required frequency for Sr-90 and VOC sampling is monthly in accordance with the SPDES equivalency permit. The pH measurement is weekly. However, samples from the influent, effluent, and midpoint locations of the treatment system were collected once a week through the second quarter 2007 in order to develop a history of resin usage. In the third quarter, the system monitoring frequency changed from weekly to two times per month. All samples were analyzed for Sr-90 and VOCs. The influent was analyzed for tritium, and both the influent and effluent were analyzed weekly for pH. Sr-90 concentrations in 2007 for the extraction wells are summarized in **Table F-41** in **Appendix F**. System influent and effluent concentrations are summarized in **Tables F-42** and **F-43**. **Table F-44** contains the monthly Sr-90 removal totals for the system.

Operation details are given in the O & M manual for this system. Below is a summary of the system operations for 2007:

January–September 2007

The treatment system was off from March 12 to March 30 for a resin vessel change-out. The entire system was off from June 1 to June 18 for electrical repairs. The treatment system was off again from July 7 through September 1 due to a lightning strike, which severely damaged the computer control center of the system. As recommended in the 2006 Groundwater Status Report, starting with the third quarter, gross beta was removed from the analyte list for the treatment system sampling.

October–December 2007

The treatment system ran normally for the entire period.

3.2.15.5 System Operational Data

The analytical data for the period January 1 through December 31, 2007 showed a Sr-90 influent range from 19 to 504 pCi/L, with the highest concentration in June. The highest tritium concentration in the influent during 2007 was 874 pCi/L, in January. Sr-90 was detected once in the effluent samples during 2007, with the concentration at 1.2 pCi/L in February, below the limit of 8.0 pCi/L (See **Table 3.2.15-1**). There were no VOCs detected in the influent or effluent in 2007 above the SPDES Equivalency Permit discharge limits. During 2007, approximately 7.6 million gallons of groundwater were processed through the system.

Cumulative Mass Removal

Average flow rates for each monitoring period were used, in combination with the Sr-90 influent concentration, to calculate the number of millicuries removed. During operation, the flow averaged 20 gpm from January 1 through December 31, 2007. Approximately 4.9 mCi of Sr-90 was removed during 2007, for a total removed since system startup in 2005 of 14.15 mCi (**Figure 3.2.15-6**).

Extraction Wells

Maximum Sr-90 concentrations in each of the extraction wells during 2007 were as follows:

- SR-1 94 pCi/L in September
- SR-2 170 pCi/L in October
- SR-3 1,650 pCi/L in September
- SR-4 27 pCi/L in December
- SR-5 128 pCi/L in December

Tritium concentrations in extraction well SR-2 decreased throughout 2007, from a high of 2,590 pCi/L in January to a low of 300 pCi/L in May.

The treatment system influent and extraction wells SR-1 and SR-2 continue to be monitored for Sr-90 and tritium. No VOCs above the drinking water standard were detected in the extraction wells during 2007.

Table 3.2.15-1.
Sr-90 BGRR Treatment System
2007 SPDES Equivalency Permit Levels

Parameter	Permit Level	Max. Measured Value
pH range	5.5–8.5 SU	6.0–6.8 SU
Sr-90	8.0 pCi/L	1.2
chloroform	7.0 µg/L	<0.5
1,1,1-trichloroethane	5.0 µg/L	<0.5

ND = Not detected above minimum detectable activity.
SU = Standard Units
Required sampling frequency was originally weekly for Sr-90, VOCs, and pH. In April 2006, the frequency changed to monthly for Sr-90 and VOCs after 6 months of non-exceedances. pH is weekly.

3.2.15.6 Groundwater Monitoring Program Evaluation

The OU III BGRR/WCF Strontium-90 Pump and Treat 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?

For WCF Plume: Yes. As discussed in **Section 3.2.15.3** above, in October 2007 a temporary well sample at location g-2-GP-63 identified Sr-90 at a maximum concentration of 518 pCi/L. This concentration was significantly higher than expected for this location. The slow migration rate of Sr-90 in the aquifer (approximately 20 to 40 feet per year) along with the location of this high concentration slug in the middle of the site and far from any sensitive receptors (e.g., potable supply wells) did not warrant any immediate actions. Preliminary groundwater modeling concluded that the recent characterization data concentrations would jeopardize meeting the OU III ESD cleanup goal of reaching DWS in 70 years. The regulators were briefed on the data during the February 14, 2008 IAG weekly teleconference.

For BGRR Plume: No.

For PFS Plume: No.

2. Has the plume been controlled?

For WCF Plume: No. Based on the monitoring well data, the area of high Sr-90 contamination near the WCF is controlled and captured by extraction wells SR-1 and SR-2. However, based on the additional temporary well data collected north of the HFBR in the fall of 2007, there are high Sr-90 concentrations that are not actively controlled. Preliminary groundwater modeling performed taking into account the recent data indicates that if left untreated, the OU III ESD cleanup objective would not be met.

For BGRR Plume: Yes. Based on the monitoring well data, the high concentration portion of the plume is being captured by extraction wells SR-3, SR-4, and SR-5. However, well 075-669 should continued to be monitored to ensure that the Sr-90 concentrations in this well do not continue to climb higher than the 272 pCi/L identified in October 2005. This portion of the plume is outside the extraction well's capture zone. Trends since 2005 show a gradual decline in Sr-90 concentrations in this well to 86 pCi/L.

For PFS Plume: Yes. Based on the monitoring well data, the high concentration portion of the plume is expected to attenuate to below DWS.

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?*

For WCF Plume: The hydraulic capture performance of the system 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 MCLs. The system is operating as planned. However, based on current model projections on the long-term restoration of the aquifer, the elevated Sr-90 concentrations identified just north of the HFBR indicate that the ESD cleanup objective of meeting DWS within 70 years (by 2070) may not be met. Additional extraction wells will be necessary to reduce the high concentration slug identified as part of the recent characterization effort to levels that will attenuate in accordance with the cleanup goal. A complication to addressing the high concentration slug is that it is co-located with tritium from the g-2 plume, well in excess of the DWS. This will not allow for pumping of the Sr-90 high concentration slug for the next one to two years. The g-2 tritium slug has been well defined, and is moving at a rate five to 10 times faster than Sr-90 in the aquifer. Once the tritium slug has moved south of this area it will be possible to pump and treat the Sr-90.

For 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. The ESD objectives are expected to be met.

For PFS Plume: Based on the Sr-90 concentrations detected this year in this plume it is attenuating as projected.

4. *Have the cleanup goals been met? Can the groundwater treatment system be shut down?*

For WCF Plume: No. The cleanup goal of meeting the DWS in the aquifer has not yet been met. However, the system is preventing and minimizing plume growth of the higher concentrations of Sr-90 near the WCF portion of the plume. As noted above, based on the temporary well data from late 2007, there are high concentration areas (518 pCi/L) of the plume near the HFBR that will slowly continue migrating if not actively addressed.

For BGRR Plume: No. The cleanup goal of meeting 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.

For PFS Plume: No. The cleanup goal of meeting the DWS in the aquifer has not yet been met.

3.2.15.7 Recommendations

The following are recommendations for the BGRR/WCF Groundwater Treatment System and monitoring program:

- Install additional temporary wells during the fourth quarter of 2008 in the area of the high Sr-90 detected in late 2007 from the WCF plume near the HFBR. Also, continue to analyze select temporary wells for Sr-90 during their installation just near the HFBR in 2008 for the g-2 tritium plume. These data will be important both to track the hot spot Sr-90 concentrations as well as to determine when the high concentration portion of the g-2 tritium plume has migrated south of this area. This will allow for additional Sr-90 extraction and treatment. These are necessary to obtain sufficient data to accurately define the extent of the high concentration Sr-90 slug and design additional extraction wells.
- Install additional Sr-90 extraction wells to address the Sr-90 hot spot identified in the WCF plume. The modification to the existing Sr-90 treatment system will consist of several new extraction wells. The location and exact number of wells will depend on the distribution of the hot spot following the departure/attenuation of the g-2 tritium slug from this area. It is currently estimated that the modification will be implemented in late 2009/early 2010. Groundwater characterization over the next couple of years will determine the implementation time.
- Supplement existing sentinel monitoring wells along Temple Place as necessary to track the leading edge of the WCF Sr-90 plume. This will be determined based on the results of temporary wells to be installed during the second quarter of 2008.
- For the BGRR plume, install temporary wells near 075-670 and 075-671 to determine the width of the downgradient portion of the plume.
- Raise the pump in BGRR plume core well 075-664 four feet to evaluate Sr-90 concentrations in a shallower portion of the aquifer.
- The monitoring well sampling frequency will be implemented in a phased approach starting in 2009:
  - Change the frequency from startup (semi-annual) to the operations and maintenance phase (annually) for the BGRR and PFS plumes.
  - Due to the additional extraction wells planned to be installed for the WCF plume in 2009/2010, the monitoring well frequency for this plume should remain at the startup phase.

- Maintain the southerly groundwater flow direction by managing the pumping of the BNL supply wells, via the oversight of the BNL Water and Sanitary Planning Committee.

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 2007, and gives conclusions and recommendations for future operation. This system began operation in February 2003.

3.2.16.1 System Description Background

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.

Following the excavation, a Sr-90 plume was characterized. As discussed in the 2006 *Groundwater Status Report*, 17 temporary wells were installed between April 2006 and February 2007 to collect additional data as a result of increasing Sr-90 concentrations downgradient of EW-1. Based on these data and the monitoring wells, the plume (as defined by the 8 pCi/L isocontour) is now approximately 650 feet long and 65 feet wide, with a maximum thickness of 15 feet. It is approximately 22 to 45 feet below ground surface. 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) occurred in very narrow bands. The first is an area at and immediately upgradient of EW-1. The second area, approximately 25 feet wide, begins around the Princeton Avenue firebreak and continues south for approximately 325 feet (**Figure 3.2.16-1).**

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 dry wells. Extraction wells EW-2 and EW-3 were installed in August and became operational in November 2007.
2. Operation of the system to minimize plume growth and meet DWS within 40 years.
3. Continued monitoring and evaluation of the data to ensure protectiveness.

Details of operations are provided in the *Strontium-90 Pilot Study Treatment System Operation and Maintenance Manual* (BNL 2004b). This manual is in being updated to reflect the additional extraction wells.

3.2.16.2 Groundwater Monitoring

Well Network

The monitoring well network was enhanced in 2007 with the addition of five wells for a total of 41. **Figure 1-2** shows the monitoring well locations.

Sampling Frequency and Analysis

Per the recommendation in the 2006 *Groundwater Status Report*, starting in the third quarter of 2007 the monitoring well sampling frequency changed from startup (semi-annual and quarterly) to the O&M phase (semi-annual and annual). Six of the 41 monitoring wells were sampled semi-annually for Sr-90; the remaining wells were sampled annually. All the wells are sampled annually for VOCs.

3.2.16.3 Monitoring Well Results

Figure 3.2.16-1 shows the Sr-90 plume distribution. The plume depiction is derived from the third and fourth-quarter monitoring well data and supplemented with the 17 temporary wells and five new monitoring wells. **Note**: The data from the temporary wells were previously included in the 2006 *Groundwater Status Report* and the 2007 *Quarterly Operations Reports*.

A summary of key monitoring well data for 2007 follows.

- The highest Sr-90 concentration observed in 2007 was 589 pCi/L in plume core well 106-16. This well is approximately 50 feet upgradient of EW-1 and is beginning to increase following two previous years of lower values (<360 pCi/L). However, Sr-90 concentrations in plume core well 106-99, slightly downgradient of 106-16, continued to remain low over the past two years despite reaching a historic high for the plume in 2005 of 4,720 pCi/L. This indicates that the slug near well 106-16 has not yet reached this location.
- Plume core well 106-49, located in the centerline of the plume approximately 170 feet downgradient of extraction well EW-1, detected Sr-90 up to 154 pCi/L. As shown in **Figure 3.2.16-2,** the 2007 data for this well are the lowest since 2003. This may indicate that the trailing edge of the high Sr-90 portion of the plume between EW-1 and this location is now moving through this area. This hypothesis is also supported by the declining trends in upgradient wells 106-103 and 106-105.
- New 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 portion of the plume. This well detected 498 pCi/L of Sr-90 in October 2007 and dropped off slightly to 320 pCi/L in December. New plume core well 106-119, located upgradient of the southern-most extraction well EW-3, detected a maximum Sr-90 concentration of 49 pCi/L also in October.
- Newly installed bypass wells 106-120, 106-121, and 106-122 are approximately 100 feet south of EW-3. No Sr-90 has yet been detected in these wells.
- Wells 106-43, 106-44, 106-45, and 106-64, approximately 500 feet west of the Chemical Holes plume, have not detected Sr-90 above the DWS since 2002. These wells are downgradient of the Former Landfill.

As noted earlier, there are two distinct portions of the plume greater than 50 pCi/L **(**see **Figure 3.2.16-1)**. The smaller area extends approximately 85 feet upgradient of EW-1. There is then a break in the 50 pCi/L isocontour from EW-1 and downgradient approximately 100 feet. Based on the data from the temporary wells and new monitoring wells, the higher concentrations (>50 pCi/L) then continue for approximately 365 feet. The leading edge of the plume, as defined by the DWS of 8 pCi/L, is approximately 500 feet south of well EW-1. New extraction well EW-2 was installed in the middle of the high concentration segment of the plume, and EW-3 was installed just ahead of the leading edge of the 50 pCi/L Sr-90 isocontour.

All monitoring wells in this program are also analyzed annually for VOCs to monitor low-level VOC contamination originating from the Chemical/Animal Holes area **Note**: The five new monitoring wells were not yet sampled in 2007 for VOCs. There were no detections of VOCs above the DWS in 2007 in any well. The complete results are in **Appendix C**.

3.2.16.4 System Operations

The Strontium-90 Chemical/Animal Holes Treatment System influent, effluent, and midpoint locations were sampled once a week, in accordance with the SPDES equivalency permit. All samples were analyzed for Sr-90. In addition, the influent and effluent samples were analyzed for pH on a monthly basis (**Table 3.2.16-1**). As per the recommendations in the 2006 *Groundwater Status Report*, in the third quarter of 2007, gross beta was removed from the analyte list for the treatment system sampling, since this parameter is no longer needed. The SPDES Equivalency Permit, which expired in January 2008, was renewed in February 2008 and the Sr-90 sampling frequency was changed from weekly to monthly. In August, two new extraction wells (EW-2 and EW-3) were installed. The new extraction wells began operating November 5, 2007. The treatment system now consists of three extraction wells. Sr-90 concentrations in 2007 for the system influent and effluent are summarized in **Tables F-45** and **F-46** in **Appendix F**. **Table F-47** contains a summary of the monthly Sr-90 mass removal for the system.

Summarized below are the system operations data for 2007. Details for this system are given in the O&M manual.

Table 3.2.16-1.
Sr-90 Chemical Holes Treatment System
2007 SPDES Equivalency Permit Levels

Parameter	Permit Level	Max. Measured Value
pH* range (SU)	5.0–8.5	5.4–6.3
Sr-90 (pCi/L)	8.0	ND

* In May 2006, the permitted pH lower limit changed from 6.5 to 5.0 SU
ND = Not detected above minimum detectable activity.
SU = Standard Units

Required sampling frequencies are weekly and monthly for Sr-90 and pH, respectively.

January–September 2007

In June 2007, a design report on the two additional extraction wells and additional monitoring wells was provided to the regulators. Construction was initiated in late June and was completed in August. The system was off for most of June and July due to a computer hardware problem. In August, the system was off for the last part of the month while the two new extraction wells were being connected. The system ran normally for September.

October–December 2007

The new extraction wells began operating November 5, 2007. The system operated normally the remainder of the quarter.

3.2.16.5 System Operational Data

The analytical data for the period January 1–December 31, 2007 show that Sr-90 in the influent ranged from 6 pCi/L to 79 pCi/L. The increase noted in November 2007 is due to the start-up of both extraction wells. All effluent samples were well below the SPDES equivalency permit level of 8 pCi/L for Sr-90. During 2007, approximately 2.4 million gallons of groundwater were processed through the system.

Cumulative Mass Removal

Average flow rates for each monitoring period were used, in combination with the Sr-90 concentration, to calculate the number of millicuries (mCi) removed. Flow averaged 6 gpm during 2007. The cumulative total was approximately 0.27 mCi of Sr-90 removed during 2007, and a total since 2003 of approximately 2.60 mCi (**Figure 3.2.16-3**).

3.2.16.6 System Evaluation

The Chemical/Animal Holes Treatment System performance can be evaluated based on the four major decisions identified for this system as part of the DQO process that was used to design the monitoring program.

1. Was the BNL Groundwater Contingency Plan triggered?

Not in 2007. Although based on the Contingency Plan being triggered in 2006, corrective measures were performed in 2007. These include:

- The installation of 17 temporary wells to further define the higher Sr-90 concentrations downgradient of EW-1
- The installation of two additional extraction wells to remediate the plume
- The installation of five additional monitoring wells to monitoring the effectiveness of the remediation system and plume reduction

2. Has the plume been controlled?

The monitoring data indicate the plume upgradient of the extraction EW-1 is controlled by the single extraction well pumping at 6 gpm. However, monitoring data collected downgradient of the extraction well in 2005 and 2006 showed significant Sr-90 concentrations (up to 1,530 pCi/L). Elevated Sr-90 concentrations, up to 356 pCi/L, were detected in the additional temporary wells installed between April 2006 and February 2007. This area of Sr-90 contamination was already downgradient of the pilot study extraction well when the well went into operation (**Figure 3.2.16-1**). Since the two additional extraction wells were installed in late 2007 the downgradient portion of the plume should be controlled. Continued monitoring of the wells over time will provide verification.

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?*
The system was designed to meet the ROD and ESD cleanup goal of reaching the maximum contaminant level (MCL) within 40 years. The design expected that the one extraction well would need to operate 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 additional two extraction wells are also expected to operate approximately 10 years as originally designed.

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 above, significant contamination remains upgradient of extraction wells EW-1, EW-2, and EW-3. If this were left untreated, the cleanup goal of meeting the MCL within 40 years 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-2 and EW-3 between 5 to 7 gpm.
- Due to the low influent concentrations, implement pulse pumping of EW-1 (cycle of 1 month on, 1 month off) beginning in January 2008. If concentrations in this extraction well increase significantly, then EW-1 will be put back into full-time operation
- Due to the increase of Sr-90 concentrations in monitoring well 106-16, install temporary wells upgradient of this location to verify that there is no continuing source of contamination. This work will be performed in mid 2008. Based on a review of the data, a monitoring well may also be installed.
- Maintain the operations and maintenance phase monitoring well sampling frequency started in 2007. Change the frequency for the five new monitoring wells from quarterly to semi-annually. Also, change the sampling frequency for well 106-99 from annual to semi-annual.
- Starting in the third quarter of 2008, drop VOC analysis from the monitoring wells, since VOCs have not been detected above the DWS since 2004.
- Transfer monitoring wells 106-20, 106-21, 106-43, 106-44, 106-45, and 106-64 to the Former Landfill groundwater monitoring program. The data will be discussed in the annual *Landfill Monitoring Report*.

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 Princeton Avenue firebreak road approximately 3,700 feet downgradient of the HFBR, to capture tritium and assure that the plume would not move 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 System.

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 GP-297 on November 2, 2006. A new extraction well EW-16 was installed in 2007 to supplement the three existing pump and recharge 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**). Evaluation of groundwater flow and quality data indicates that the downgradient portion of the tritium plume (south of Brookhaven Avenue) has shifted east since 1997 in response to decreased cooling water discharges to the HO recharge basin, the OU III recharge basin, and the reduced pumping of BNL’s eastern supply wells 10, 11, and 12. The eastward shift can also be seen by observing the sharp declines in tritium concentration for monitoring wells 075-294, 075-418, 085-287, and 085-78 in **Figure 3.2.17-3**.

3.2.17.1 HFBR Pump and Recharge System

Operation of the system resumed in November 2007 as a result of the implementation of the ROD contingency described above and included the pumping of wells EW-16 and EW-11. Extraction well EW-16 was installed in 2007 approximately 400 feet north of the existing pump and recharge wells located on the Princeton Avenue firebreak road (**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 monthly frequency. A pre-startup 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 pCi/L to 2,530 pCi/L. Complete system operations and system evaluation reporting will resume in the 2008 Groundwater Status Report.

3.2.17.2 System Description

For a complete description of the HFBR Tritium Pump and Recharge System, see the *Operation and Maintenance Plan for the High Flux Beam Reactor Tritium Plume Pump and Recharge System* (BNL 1998). The O&M Plan is currently being updated to incorporate the modifications to the system.

3.2.17.3 Groundwater Monitoring

Well Network

A monitoring well network of 116 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 being supplemented with a semi-annual temporary well characterization. A total of 27 temporary wells were installed and sampled in 2007 and the first quarter of 2008. Eight temporary wells were installed between July 17 and August 2, and 19 temporary wells were installed between January 14 and February 27, 2008 (**Figure 3.2.17-1**) and **Table 3.2.17-1**.

Sampling Frequency and Analysis
Sampling details for the well network are contained in **Table 1-5**. Select wells are also analyzed for VOCs as part of the Carbon Tetrachloride and Middle Road programs.

3.2.17.4 Monitoring Well Data

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 2007, supplemented with data obtained from 27 temporary wells at 20 locations installed from December 2007 through March 2008. The temporary wells were undertaken to fill in data gaps along key segments of the plume. The temporary wells were installed east of the existing monitoring well network along transects established at Temple Place, east of Bell Avenue, east of the Chilled Water Facility Road, east of Weaver Drive, and immediately north of EW-16, as shown in **Figure 3.2.17-1**. **Appendix C** has the complete set of monitoring well data. Data from temporary wells installed from July 2007 through March 2008 are summarized in **Table 3.2.17-1**. A north–south cross-sectional view of the plume centerline is shown in **Figure 3.2.17-2**. Tritium concentration trends for key monitoring wells are shown in **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 2007 was consistently to the south. Supply well 10 remained in standby mode the entire year, while wells 11 and 12 operated minimally. As a result there was no northward migration of tritium in groundwater. It should be noted that tritium was detected in well 065-39 at a concentration of 31,700 pCi/L in 2007. This well is approximately 400 feet northwest of the HFBR. The tritium observed in this well originates from the g-2 source area. A characterization of the downgradient extent of the g-2 tritium plume was conducted in 2007 and is summarized in **Section 4.2**.This plume is present in the vicinity of the HFBR, approximately 10 to 20 feet deeper than the HFBR plume.

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 (**Figure 3.2.17-4**. There is an approximate nine- to 12-month lag time between peak water table conditions and observed tritium concentration increases in wells immediately downgradient of the HFBR. The tritium concentrations detected in monitoring wells that are immediately downgradient of the HFBR and associated with the periodic water table rises that are mobilizing tritium beneath the source area are trended in **Figure 3.2.17-5**. A steady decrease is observed with respect to these peak tritium concentrations over time. Based on the 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 centerline of the tritium plume from the HFBR to Brookhaven Avenue shifted to the east along Cornell Avenue in early 2006 and has remained relatively steady since that time, as can be seen in the tritium concentration in wells 075-240 and 075-245, which are at the east end of the monitoring well network on Cornell Avenue (**Figure 3.2.17-3**).

The peak tritium concentration in this area, 200,000 pCi/L in well 075-240 in July 2007, probably resulted from the water table rise in June 2006. Tritium concentrations in this well steadily decreased to 9,700 pCi/L in December of 2007. Based on the declining water table elevation in late 2007 and early 2008, the tritium concentrations observed immediately downgradient of the HFBR are expected to continue decreasing in 2008.

Brookhaven Avenue to Weaver Drive

The monitoring well network in this area was supplemented with 10 temporary wells during 2007/2008. Locations 095-278 and 095-272 were sampled twice during this period. The only significant change to the plume in this area was the migration of the break in the 20,000 pCi/L contour to an area between Temple Place and just north of Brookhaven Avenue, as shown in **Figure 3.2.17-1**. This break was created by the intermittent nature of tritium flushing in the vadose zone beneath the HFBR over the past several years.

In the first quarter of 2008, the highest concentration segment of the HFBR tritium plume continues to be located at and just south of Chilled Water Facility Road. The highest tritium concentration detected was 118,000 pCi/L, in temporary well GP-282, in August 2007. This was similar to the high concentration at this location in 2006 of 97,000 pCi/L. The trailing edge of the higher concentration slug should be approaching this location, which is scheduled to be sampled again in July 2008.

Weaver Drive to Princeton Avenue Firebreak Road

A temporary well characterization effort was conducted in this area during the second quarter of 2007 and the first quarter of 2008 to supplement the monitoring well network. The highest detection observed along Weaver Drive was 65,800 pCi/L in GP-300 in late January 2008. Temporary well GP-349 was installed mid-way between Weaver Drive and EW-16 in March 2008 and detected 82,300 pCi/L tritium (**Figure 3.2. 17-1**). Temporary well GP-340, located approximately 100 feet north of EW-16, detected 10,000 pCi/L in March 2008. Based on these characterization data, the leading edge of the plume, as defined by concentrations greater than 20,000 pCi/L, is approaching the vicinity of EW-16. EW-16 is being sampled on a monthly basis, and concentrations to date have not reflected the plume reaching this well. **Table F-48** in Appendix F presents the VOC and tritium 2007 detections in the extraction wells.

3.2.17.5 Groundwater Monitoring Program Evaluation

The OU III HFBR Tritium Monitoring Program can be evaluated based on five major decision rules established for this program using the groundwater DQO process.

1. Was the BNL Groundwater Contingency Plan triggered?

No. The 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 2007. EW-16 was installed and the Pump and Recharge system restarted in 2007 in response to triggering the ROD contingency of 20,000 pCi/L at Weaver Drive in 2006.

2. Is the tritium plume growing?

Based on the position of the 20,000 pCi/L isocontour line, the high concentration segment of the plume has migrated to a location immediately north of EW-16, which is positioned to capture the plume. See **Figure 3.2.17-6** for the plume distribution comparison between 1997 and 2007.

3. Are observed conditions consistent with the attenuation model?

Yes. The BNL groundwater model 2003 update predicted that the remnants of the hot spot would reach Weaver Drive in approximately the late 2005 time frame at concentrations between 30,000 and 60,000 pCi/L. Observed conditions with respect to both tritium concentrations and hot-spot position matched the model predictions reasonably well. The observed concentration of 82,300 pCi/L between Weaver Drive and EW-16 in 2008 is slightly higher the model predicted concentration (20,000 – 40,000 pCi/L), but within an acceptable error range for a 5-year prediction.

4. Is the tritium plume migrating toward the zone of influence of water supply wells 10, 11, and 12?

No. Groundwater flow from this area was to the south during 2007 (**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 tritium Pump and Recharge System and monitoring program:

- Continue monitoring well sampling schedule initiated in 2006.
- Continue to install and sample temporary wells twice per year over the next several years to characterize the location of the high tritium concentration area, and results will be communicated to the regulators via the IAG conference call and quarterly/annual reports.
- Continue operating EW-16 and EW-11 in 2008. Monitor tritium concentrations in EW-16 on a monthly basis.
- The pump and recharge well(s) will be operated until the tritium concentrations from Weaver Drive to the new extraction well drop below 20,000 pCi/L. The estimated operational duration of 2 to 4 years is based on the length of the high concentration area slug and the time it would take to be completely captured by the new extraction well. The decision to turn the wells back to standby will be based on; 1) concentrations of tritium being less than 20,000 pCi/L in the monitoring wells at Weaver Drive as well as the extraction wells, and 2) verification that the new extraction well has captured concentrations of tritium in this area greater than 20,000 pCi/L. This decision to turn the wells back to standby will be supported with data from additional permanent and temporary wells, as needed.

3.3 OPERABLE UNIT IV

3.3.1 Post Closure Monitoring (Former OU IV AS/SVE System)

The OU IV Air Sparge 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.

A Five-Year Review Report for OU IV was submitted to the regulators in June 2002. Following revisions made based on regulator comments, a final report was approved in September 2003. This report included changes to the continued groundwater monitoring program.

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 OU IV AOC 6 Program or abandoned as per the final report (BNL 2003b) **(Figure 1-2).**

Sampling Frequency and Analysis

The sampling frequency for these wells is semi-annually for VOCs and SVOCs.

3.3.1.2 Monitoring Well Results

Post-closure sampling of monitoring wells was conducted for 2007. The complete groundwater data are given in **Appendix C**. There were no detections of SVOCs in any of the samples collected. No samples exceeded the NYS AWQS for VOCs during 2007.

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 2007.

3.3.1.4 Recommendations

The following are recommendations for the OU IV AS/SVE Post Closure Monitoring program:

- Reduce frequency of sampling from semiannual to annual due to the lack of detections of VOCs and SVOCs.

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3.3.2 Building 650 Strontium-90 Monitoring Program

The Building 650 Strontium-90 Monitoring Program monitors a Sr-90 plume emanating from a former 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 29 wells used to monitor the Sr-90 concentrations originating from the former Building 650 sump and sump outfall area. (**Figure 1-2**).

Sampling Frequency and Analysis

During 2007, the wells were monitored either annually or semi-annually and the samples were analyzed for Sr-90 (**Table 1-5**).

3.3.2.2 Monitoring Well Results

The complete results from radionuclide sampling can be found in **Appendix C**. The overall extent of the Sr-90 plume originating from the Building 650 sump outfall has not changed significantly over the past several years, as it continues to migrate slowly southward while attenuating in the vicinity of well 076-24 (**Figure 3.3.2-1**). The leading edge of the plume is presently located just to the southwest of well 076-24. The highest Sr-90 concentrations were detected in well 076-169, at 25 pCi/L, in January 2007. In general, the concentrations in wells associated with the Building 650 sump and sump outfall plume displayed declining trends during 2007 (**Figure 3.3.2-2**).

Sr-90 concentrations in well 076-28 are shown in **Figure 3.3.2-2**. This well is immediately north of Building 650, adjacent to the former decontamination pad where contaminated soils were removed in 2002. Periodic increases in Sr-90 concentrations have been observed in this well over the past several years. The Sr-90 data from this well, which dates back to 1997, was compared to water table elevation data to identify whether the increases may be in response to periodic water table rises that flush out residual Sr-90 residing in the unsaturated zone in the vicinity of the pad/building. This water table flushing process has been observed in several former source areas across the site, including the HFBR, BGRR, and g-2. Based on an analysis of the data there does not appear to be a direct correlation between water table elevation and Sr-90 concentration in this well. Sr-90 concentrations were also compared to precipitation data over the history of the well with no observable correlation.

3.3.2.3 Groundwater Monitoring Program Evaluation

The system 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 in groundwater during 2007.

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 four monitoring wells exceeding this limit in 2007. 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 Recommendation

The following recommendation is made for the Building 650 Strontium-90 Groundwater Monitoring Program:

- Reduce the sampling frequency for monitoring wells 076-25, 076-26, 076-314, 076-317, 076-373, 066-189, and 066-190 to annual. There have been no significant detections of Sr-90 in these wells over the past several years. Several of these wells (076-314, 066-189, and 066-190) are no longer downgradient of the source area due to changes in groundwater flow resulting from the diminished water table mounding at Basin HO. The sampling frequencies can be increased if warranted by future changes in groundwater flow conditions.

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 boundary, and off site (**Figure 1-2**). BNL's Groundwater Model was used to aid in placing these wells.

Sampling Frequency and Analysis

Wells are sampled semi-annually and samples are analyzed for VOCs, perchlorate, and tritium (**Table 1-5**). Sample frequency will be reduced to annual in 2008 based on the 2006 *Groundwater Status Report* recommendation.

3.4.3 Monitoring Well Results

The OU V wells were sampled during two rounds in 2007. **Appendix C** contains the complete data. The VOC plume consists of an area of less than 8 μg/L TVOCs that extends from south and east of the STP southeast to the vicinity of the Long Island Expressway (**Figure 3.4-1**). During 2007, the highest TVOC concentration was 8 μg/L in well 000-122, located just north of the expressway. In general, 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)**. The only individual VOC detected at levels exceeding NYS AWQS was TCE, at 5.2 μg/L. 2007 was the first year since 1998 that 1,2-dichloropropane has not been detected in shallow off-site sentinel well 600-25 at concentrations exceeding the NYS AWQS of 1 μg/L. It is believed that the previous detections in this well originated from an off-site source, based on the shallow depth and distance from the site (approximately 4,000 feet) at which it was detected. There have been no significant changes to the VOC plume over the past several years, other than the gradual decline in concentrations (**Figure 3.4-2**). A comparison of the plume from 1997 to 2008 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 SCDHS. In June of that year, perchlorate had been detected in SCDHS monitoring well EG-A (off site and east of BNL) in a sample from the deep section of the Upper Glacial aquifer. Perchlorate was detected during the August 2004 sampling event in four of the 34 BNL wells (049-06, 050-02, 061-04, and 061-05), with concentrations ranging between 5.0 and 12.7 μg/L. The NYSDOH Action Level for perchlorate in drinking water supply wells is 18 μg/L. The US EPA published a new Drinking Water Equivalent Level for perchlorate of 24.5 μg/L in January 2006.

In 2007, eight OU V wells (000-122, 000-123, 049-05, 049-06, 050-01, 050-02, 061-04, and 061-05) were analyzed for perchlorate during two sampling rounds. The compound was detected in wells 049-06 and 061-05, which monitor the deep portion of the Upper Glacial aquifer. Well 049-06 is near the eastern firebreak road and well 061-05 is at the eastern site boundary. The maximum perchlorate concentration, detected in well 061-05, was 4.6 μg/L, which is significantly below the NYSDOH action level. Concentrations in wells 049-06 and 061-05 continue the steady decline observed over the past several years. The same eight OU V wells will be sampled for perchlorate again in 2008.

Tritium has historically been detected at low concentrations in monitoring wells 049-06, 050-02, and 061-05. The maximum tritium concentration during 2007 was 1,260 pCi/L, in well 061-05; this is approximately one-twentieth the DWS of 20,000 pCi/L. Tritium was not detected in the off-site monitoring wells.

3.4.4 Groundwater Monitoring Program Evaluation

1. Was the BNL Groundwater Contingency Plan triggered?
No. There were no unexpected contaminant concentrations in groundwater during 2007.

2. Were the performance objectives met?
No. 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. These standards continue to be exceeded in only one of the monitoring wells in early 2008.

3. Is the extent of the plume still defined by the existing monitoring well network?
Yes. The leading edge of the 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 recommendation is made for the OU V plume groundwater monitoring program:

- Due to the low concentrations of perchlorate being detected, reduce the frequency of this analysis from semi-annual to annual for the eight monitoring wells.

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 site boundary to south of North Street. EDB was used during the 1970s as a fumigant for the BNL Biology Department's agricultural fields located in the southeastern portion of the site. 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. Currently, only trace levels of EDB are detected on the site 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 Treatment System consists of two extraction wells and two recharge wells. A complete description of the system is included in the *Operation and Maintenance Manual for the OU VI EDB Groundwater Treatment System* (BNL 2004e).

3.5.2 Groundwater Monitoring

Well Locations

A network of 30 wells monitor the EDB plume from the former source area in the Biology Department's agricultural fields to locations on private property south of North Street (**Figure 3.5-1**).

Sampling Frequency and Analysis

Beginning with the third quarter of 2006, the OU VI plume monitoring program moved into the O&M phase (see **Table 1-7**). The sampling frequency for plume core and perimeter wells (**Table 1-5**) was reduced from quarterly to semi-annually. The exception to this was perimeter well 000-498, which remained at a quarterly sampling frequency for the year. The wells are analyzed for EDB by EPA Method 504. Samples are also analyzed annually for VOCs. Several wells were incorporated into the OU III South Boundary Radionuclide monitoring program and analyzed for tritium annually. The inclusion of these wells will allow for radionuclide monitoring across the entire downgradient site boundary. (**Table 1-5**).

3.5.3 Monitoring Well Results

Appendix C contains the complete results of the sampling program. The distribution of the EDB plume is shown for the fourth quarter of 2007 (**Figure 3.5-1**). The leading edge of the plume is currently being captured by extraction wells EW-1E and -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 2007 follows:

- The highest EDB concentration observed in the plume during 2007 was 2.3 µg/L, in core well 000-283. This is less than the maximum EDB concentrations reported in 2004, 2005, and 2006 of 4.1 µg/L, 3.4 µg/L, and 2.9 µg/L, respectively, in well 000-284. As seen in trend **Figure 3.5-3, EDB** in this well has remained stable over the past several years. 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 few years in upgradient plume core wells 000-110, 000-175, and 000-209. Plume core wells 000-283 and 000-284 have remained stable. They contained the highest plume concentrations over the past 2 years. Core well 000-507 has detected gradually increasing levels of EDB since it was installed in 2005.
- Well 000-178, also installed in 2005, is upgradient of EW-2E. This well has also been detecting increased values since late 2006.

- Plume perimeter well 000-500, in the eastern portion of the plume, has increased to above the DWS in 2007 with detections of 0.071 µg/L and 0.23 µg/L. The last detection previously above the DWS in this well was in 2005, at 0.087 µg/L. This portion of the plume will be captured by EW-2E.
- Plume bypass well 000-508 has not detected any EDB since the system began operations.

As noted above, the southward migration of the plume can be observed by analyzing the trends in **Figure 3.5-3**. Over the past three years, EDB has increased in well 000-507, indicating that the core of the plume is located between well 000-507 and wells 000-283 and 000-284. Comparing the plume's distribution from 1999 to 2007 in **Figure 3.5-4** , as well as the EDB concentrations in monitoring wells just south of North Street**,** also helps to illustrate the southward movement of the plume. Overall, peak EDB concentrations have been reduced from 7.6 µg/L in 2001 (in well 000-283) to 2.3 µg/L (also in well 000-283) in 2007.

EDB was the only VOC detected above the MCL in any well in 2007 (**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 now monthly. All samples were analyzed for VOCs and EDB. The effluent sample is analyzed weekly for pH. **Table 3.5-1** provides the effluent limitations for meeting the requirements of the SPDES permit equivalency.

Table 3.5-1
OU VI EDB Pump & Treat System
2007 SPDES Equivalency Permit Levels

Parameters	Permit Limit	Max. Measured Value
pH (range)	5.0 – 8.5 SU	5.3 – 7.2 SU
ethylene dibromide	5.0 µg/L	<0.50 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

Required sampling frequency is monthly for VOCs and weekly for pH.

January through September

The system operated with EW-1E and EW-2E running at 150 gpm each for almost this entire period. EW-2E was off from March 15 to April 16 for repairs to the flow meter. EW-1E was off for a half month in June for repairs to the flow meter. During this period approximately 115 million gallons of water were pumped and treated.

October through December

EW-1E was off from November 6 to November 26 for repairs. The system operated normally for the remainder of this period.

Extraction Wells

During 2007, 138 million gallons were pumped and treated by the OU VI EDB System, with an average flow rate of approximately 300 gpm. **Table 2-3** contains the monthly pumping data for the two extraction wells. VOC concentrations for EW-1E (000-503) and EW-2E (000-504) are provided in **Table F-49** in **Appendix F**. There were several low-level detections of EDB in extraction well EW-1E during 2007, with a maximum of 0.045µg/L. There were no EDB detections in EW-2E. No other VOCs were detected in the extraction wells above the MCLs.

System Influent and Effluent

All discharge parameters were below the regulatory limit specified in the SPDES equivalency permit. Influent and effluent results are reported in **Tables F-50 and F-51** , respectively. There were several detections of EDB in the influent throughout 2007, with a maximum concentration of 0.032 µg/L. These detections were below the federal DWS of 0.05 µg/L.

Cumulative Mass Removal

No cumulative mass calculations were performed, based on the low detections of EDB below the federal DWS in the system influent. 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 Data

The OU VI EDB System was designed to capture and remediate the EDB plume as it travels off site south of BNL with the regional groundwater flow. Startup of the system was initiated in August 2004, and it is planned to run for approximately 10 years. 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 2007 except in perimeter well 000-500, located just upgradient and slightly east of extraction well EW-2E. As noted above, this well had two detections of EDB in 2007, with a maximum of 0.23 µg/L. Extraction well EW-2E is expected to capture this portion of the plume.

3. Is the system operating as planned? Specifically, is the aquifer being restored at the planned rate?

The hydraulic capture of the system is operating as designed. In 2006, EDB was only detected twice in the system influent; however, in 2007 EDB was detected in the system influent monthly. These detections were at concentrations below the federal DWS. Based on the location of the trailing edge of the plume, the aquifer is being restored at the planned rate.

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 ?

There are currently seven of eight plume core wells with 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?

The OU VI EDB system has not been pulsed to date.

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:

- Add another plume bypass well east of well 000-508 and slightly deeper, to verify that EDB is being captured by extraction well EW-2E.
- Maintain the routine operation and maintenance monitoring frequency that began in third-quarter 2006.
- Since there were no detections above the DWS for EDB in well 000-498 for 2006 and 2007, change the sampling frequency for this well from quarterly (system start-up phase) to semi-annually (O&M phase). Also change the frequency for on-site wells 058-02, 089-13, 089-14, 099-06, 099-10, 099-11, 100-12, 100-13, and 100-14 to annual, since there have been no detections of EDB above the federal DWS since mid 2003.

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 2007 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 data for 2007 is provided in **Appendix C**. There were detections of low levels of several VOCs in the site background wells. All VOC detections were below NYS AWQS. The highest concentration detected was chloroform, at 0.95 µg/L in well 017-01.

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 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 2007. Based on these results, there is no current impact to BNL groundwater quality from upgradient contaminant sources.

3.6.4 Recommendations

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	1,000

Notes:
<MDA = Less than minimum detectable activity

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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 2007 Environmental Monitoring Report, Current and Former Landfill Areas* (BNL 2008a). This report can be found in **Appendix H**. 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 2007 the landfill had been capped for 12 years. Groundwater quality has been slowly improving. The trend in the data suggests that the cap is effective in mitigating contamination. The following is a summary of the results from the samples collected during 2007:

- VOCs, such as benzene and chloroethane, continue to be detected in downgradient wells 087-11, 087-23, 087-27, 088-109, and 088-110 at concentrations above NYS AWQS. These wells are screened in the upper 20 feet of the aquifer. The maximum VOC concentration (chloroethane) in 2007 was 36.1 µg/L, in well 088-109. TVOC concentrations in these five wells ranged between 2.29 µg/L to 38 µg/L during 2007, indicating that low-level VOCs continue to emanate from the landfill. The continued presence of these compounds is expected.
- Landfill water chemistry parameters and metals (which include total dissolved solids, total suspended solids, alkalinity, ammonia, iron and manganese) evaluated during the year suggest that leachate continues to emanate from the landfill. The continued presence of these leachate indicators is expected.
- Tritium and Sr-90 continue to be detected in the wells downgradient of the Current Landfill, but at concentrations well below the drinking water standards. These concentrations, up to 673 pCi/L and 2.91 pCi/L of tritium and Sr-90, respectively, were consistent with those observed in 2006.
- Since 1998, there have been no detections of VOCs, metals, water chemistry parameters, or radionuclides exceeding NYS AWQS 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.

3.7.2 Current Landfill Recommendation

No changes to the 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 the remaining contamination from entering the groundwater. Based on the declining VOC and Sr-90 concentration trends in downgradient wells, it appears that the landfill cap is performing as planned. The following is a summary of the results from the samples collected during 2007:

- The Former Landfill is not a significant source of VOC contamination. No VOCs were detected above NYS AWQS in 2007. VOC concentrations in the downgradient wells were at or near the minimum detection limits.
- The Former Landfill no longer appears to be a source of Sr-90 contamination to groundwater. The approximated Sr-90 plume (as defined by concentrations exceeding 8 pCi/L) has migrated south

of well 097-64 and continues to attenuate below 8 pCi/L. The Sr-90 concentration in well 097-64 reached a historic high of 12 pCi/L in January 1998 and has been below 8 pCi/L since January 2000.

- Landfill-leachate indicators such as sulfate, nitrite, nitrate, chloride, and alkalinity in downgradient wells were detected at concentrations consistent with background, indicating that leachate generation is minimal to nonexistent. The implemented landfill controls are effective, as evidenced by the improving quality of groundwater downgradient of the landfill.

3.7.4 Former Landfill Recommendation

No changes to the monitoring program are warranted at this time

4.0 ENVIRONMENTAL SURVEILLANCE PROGRAM SUMMARY

During 2007, the Environmental Surveillance (ES) Program at BNL monitored the groundwater quality at 10 active 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 is implementing this part of the Environmental Management System to collect information on groundwater quality, and will use the data to determine whether current engineered and administrative controls effectively protect groundwater quality and whether additional corrective actions are needed.

During 2007, 125 groundwater surveillance wells were monitored during approximately 240 individual sampling events. Information on groundwater quality at each of the monitored research and support facilities is described below. **Table 1-6** summarizes the ES Groundwater Monitoring Program by project. Complete analytical results from groundwater samples collected in 2007 can be found 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, g-2 experimental area, E-20 Catcher, former U-Line 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 400 pCi/L for sodium-22.

To prevent rainwater from leaching these radionuclides from the soil, impermeable caps have been constructed over many of the soil activation 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 56 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**. During 2007, all 56 AGS monitoring wells were used to evaluate groundwater quality within the AGS Complex. The wells are routinely monitored for tritium. Routine analysis for sodium-22 was dropped from the groundwater surveillance program in 2002 because tritium is the best indicator of possible cap failure.

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 and E-20 Catcher areas. As discussed below, tritium concentrations greater than 20,000 pCi/L continue to be detected downgradient of the g-2 (VQ-12 magnet) soil activation area (see **Section 4.2**).

Historical surface spills and discharges of solvents to several cesspools and recharge basins near the AGS contaminated the groundwater with volatile organic compounds (VOCs). VOC contaminated groundwater within the AGS complex is monitored under the Long Term Response Actions (LTRA) program's Operable Unit III Central monitoring program (see **Section 3.2.12**).

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). A typical beam line consists of bending and focusing electromagnets, vacuum pipes, instrumentation, high-voltage electrostatic devices, beam targets, radiation shielding, cooling water systems, and experimental detectors. Although these beam lines stopped operations in 2002, plans are being developed to reconfigure the experiment area for new experiments.

Beam loss and the production of secondary particles at proton target areas result in the activation of adjacent equipment, the floor, and probably the soil beneath the floor. The highest levels of soil activation beneath Building 912 are expected at the former B-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

Seventeen shallow Upper Glacial aquifer wells are positioned upgradient and downgradient of Building 912 (**Figure 4-1**). Upgradient wells 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. Six of the downgradient wells are also used to track a section of the g-2 tritium plume that has migrated below Building 912 (see **Section 4.2**).

Sampling Frequency and Analysis

During 2007, the six Building 912 wells that are used to track the g-2 tritium plume were sampled three times, whereas the remaining wells were sampled annually. The groundwater samples were analyzed for tritium (**Table 1-6**). Analytical results for 2007 are presented in **Appendix D**.

4.1.1.2 AGS Building 912 Monitoring Well Results

Other than low level tritium contamination that is traceable to the g-2 source area, groundwater surveillance data for 2007 indicate that tritium is not being released from activated soil beneath the experimental floor of Building 912. The g-2 tritium plume has been tracked from the VQ-12 magnet source, beneath a portion of Building 912, to the High Flux Beam Reactor (HFBR) facility (**Figure 4-8**). Tritium from this plume was detected in five wells downgradient of Building 912, with a maximum concentration of 16,400 pCi/L in the January 2007 sample from well 065-123. As described in **Section 4.2**, remedial actions for the g-2 source area and tritium plume are described in the Record of Decision signed in May 2007 (BNL 2007b).

4.1.1.3 AGS Building 912 Groundwater Monitoring Program Evaluation

As noted above, in areas not impacted by the g-2 tritium plume, tritium was not detected in the Building 912 area groundwater monitoring wells. These results indicate that the building and associated stormwater management operations are effectively preventing rainwater from infiltrating activated soil below the experimental hall. For 2008, the Building 912 wells used to track the g-2 tritium plume will be sampled semiannually, whereas the remainder of the Building 912 monitoring wells will 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 in the original beam stop location.

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 to prevent stormwater infiltration.

4.1.2.1 AGS Booster Groundwater Monitoring

Well Network

Two shallow Upper Glacial aquifer monitoring wells (064-51 and 064-52) are approximately 50 feet downgradient of the current beam stop (**Figure 4-1**).

Sampling Frequency and Analysis

The Booster area wells were scheduled to be sampled one time during 2007, with the samples being analyzed for tritium (**Table 1-6**). However, access to the wells was prevented during 2007 due to beam line operations.

4.1.2.2 AGS Booster Monitoring Well Results

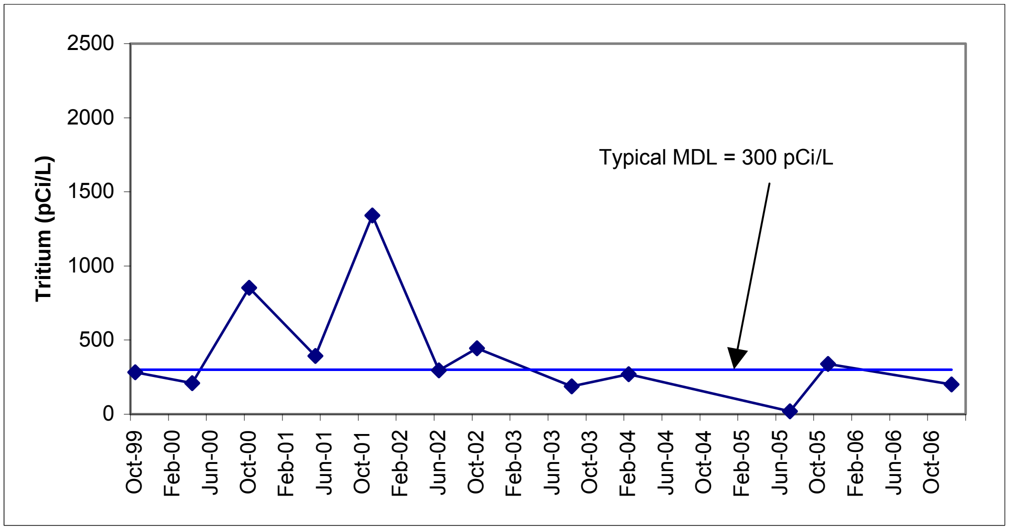
Although low levels (up to 1,340 pCi/L) of tritium were detected downgradient of the AGS Booster stop during 2001 and 2002, tritium has not been detected since that time (**Figure 4-2**). As noted previously, the Booster area wells were not sampled during 2007, due to access limitations.

4.1.2.3 AGS Booster Groundwater Monitoring Program Evaluation

The low-levels of tritium detected during 2001 and 2002 near the Booster beam stop 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 2003. No changes to the monitoring frequency for these wells are proposed for 2008.

[1] Before construction of the NSRL tunnel commenced, soil samples were collected by drilling through the tunnel wall near the 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.
Maximum Tritium Concentrations Downgradient of AGS Booster Beam Stop (Wells 064-51 and 064-52).



4.1.3 NASA Space Radiation Laboratory Facility

The NSRL facility is jointly managed by the U.S. Department of Energy's Office of Science and NASA's Johnson Space Center. The NSRL facility 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 Facility Groundwater Monitoring

Well Network

Two shallow Upper Glacial aquifer monitoring wells (054-08 and 054-191) are located immediately downgradient of the NSRL facility (**Figure 4-1**).

Sampling Frequency and Analysis

The NSRL area wells were scheduled to be monitored one time during 2007 with the sampled being analyzed for tritium (**Table 1-6**). However, access to the wells was prevented during 2007 due to beam line operations.

4.1.3.2 NSRL Facility 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.

4.1.4 AGS E-20 Beam Catcher

The E-20 beam 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. The E-20 Catcher picked up about 80 to 90 percent of all losses resulting from beam injection, transition, and ejection in the AGS Ring.

Like other beam loss areas in the AGS complex, the soil surrounding the 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 AGS E-20 Catcher Groundwater Monitoring

Well Network

To verify the effectiveness of the impermeable cap over the E-20 Catcher, the area is monitored by three shallow Upper Glacial aquifer wells 064-55, -56, and -80. These wells are approximately 100 feet downgradient of the source area (**Figure 4-1**).

Sampling Frequency and Analysis

During 2007, the E-20 Catcher wells were monitored one time, and the samples were analyzed for tritium (**Table 1-6**). Analytical results for 2007 are presented in **Appendix D**.

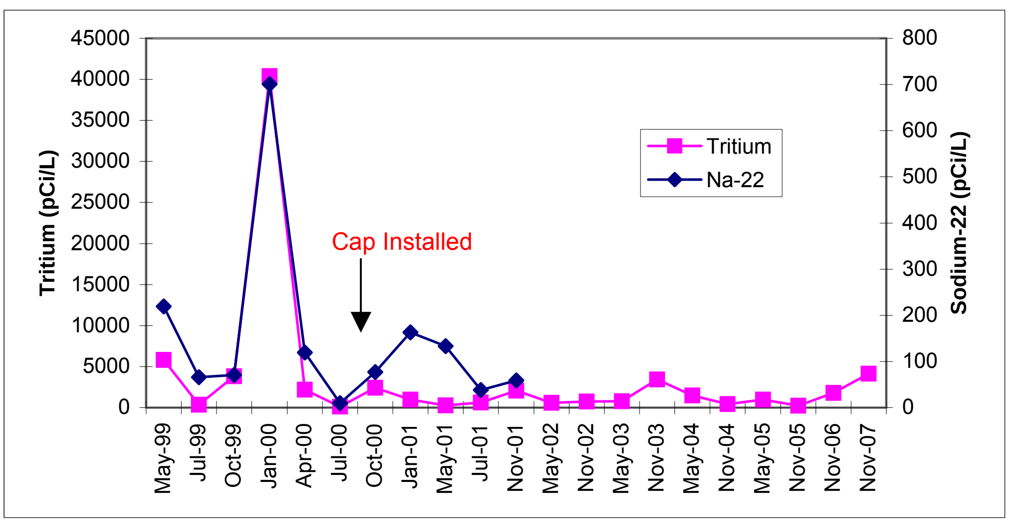
4.1.4.2 AGS E-20 Catcher Monitoring Well Results

Following the installation of the cap in 2000, tritium and sodium-22 concentrations decreased to levels below applicable DWS (**Figure 4-3**). During 2007, the maximum observed tritium concentration was 4,140 pCi/L, detected in well 064-80.

4.1.4.3 AGS E-20 Catcher Monitoring Program Evaluation

The reduction in tritium concentrations since the impermeable cap was constructed over the 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. For 2008, the monitoring frequency for the E-20 Catcher wells will continue to be annual.

Figure 4-3.
Maximum Tritium and Sodium-22 Concentrations in Temporary and Permanent Monitoring Wells Downgradient of the Former E-20 Catcher.



4.1.5 AGS Building 914

Building 914 houses the 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 will be protected from water infiltration.

4.1.5.1 AGS Building 914 Groundwater Monitoring

Well Network

Groundwater quality downgradient of the Building 914 transfer line area is monitored by three shallow Upper Glacial aquifer wells (**Figure 4-1**).

Sampling Frequency and Analysis

During 2007, the Building 914 area wells were monitored one time and samples were analyzed for tritium (**Table 1-6**). Analytical results for 2007 are presented in **Appendix D**.

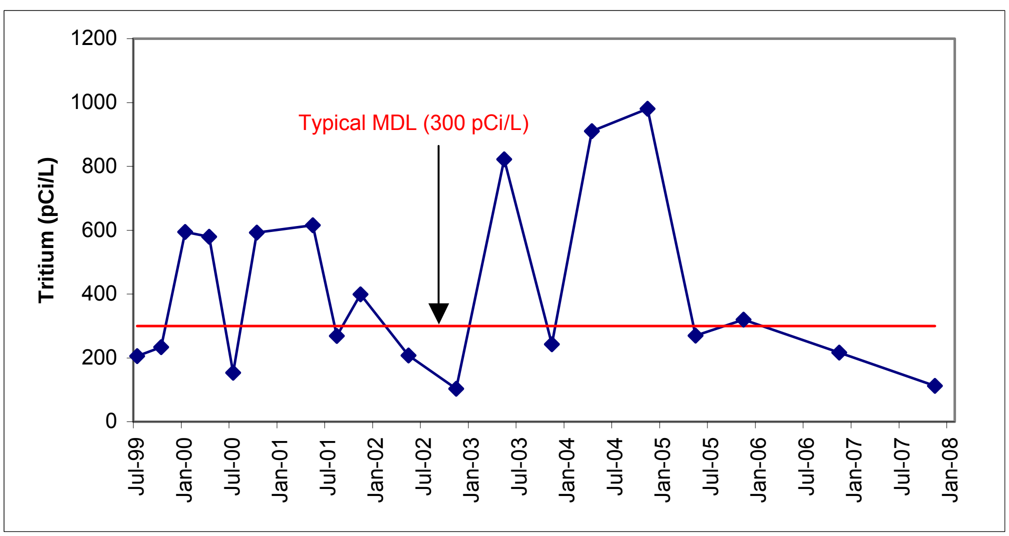
4.1.5.2 AGS Building 914 Monitoring Well Results

Low levels of tritium were detected intermittently in groundwater downgradient of the Building 914 transfer tunnel during 2000 – 2005 (**Figure 4-4**). During 2006 and 2007, tritium was not detected in any of the groundwater samples.

4.1.5.3 AGS Building 914 Groundwater Monitoring Program Evaluation

Groundwater monitoring downgradient of 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 since 2000 suggests that some rainwater may be infiltrating the activated soil. Continued monitoring is required. For 2008, the monitoring frequency for the Building 912 area wells will continue to be annual.

Figure 4-4.
Maximum Tritium Concentrations Downgradient of the 914 Transfer Tunnel (Wells 064-03, -53, and -54).



4.1.6 g-2 Beam Stop

The g-2 experiment operated from April 1997 until April 2001. The g-2 beam stop is composed of iron, and is covered by soil. Like other beam loss areas in the AGS complex, the 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 beam stop, BNL installed a gunite cap over the stop area before the start of beam line operations.

In November 1999, monitoring wells approximately 250 feet downgradient of the g-2 experimental area detected the presence of tritium and sodium-22 in the groundwater. 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 existing 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 Record of Decision, which was signed in May 2007 (BNL 2007b). The monitoring program for the VQ12 source area and g-2 tritium plume are described in **Section 4.2**, below.

4.1.6.1 g-2 Beam Stop Groundwater Monitoring

Well Network

Groundwater quality downgradient of the g-2 beam stop is monitored using three downgradient wells, (**Figure 4-1**).

Sampling Frequency and Analysis

During 2007, the g-2 beam stop wells were monitored annually, and the samples were analyzed for tritium (**Table 1-6**). Analytical results for 2007 are presented in **Appendix D**.

4.1.6.2 g-2 Beam Stop Monitoring Well Results

During 2007, tritium was not detected in any samples from the three monitoring wells located downgradient of the g-2 beam stop.

4.1.6.3 g-2 Beam Stop Groundwater Monitoring Program Evaluation

Monitoring of wells downgradient of the g-2 beam stop indicates that the cap is effectively preventing rainwater from infiltrating the activated soil shielding. During 2008, the 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 is subject to the same injection, transition, ejection and studies losses that occurred at the former E-20 Catcher, discussed earlier. Because the J-10 stop area of the AGS Ring is covered by layers of soil-crete (a sand and concrete mixture), the ability of rainwater to infiltrate the potentially activated soil has been reduced. 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 one upgradient (054-62) and two downgradient wells (054-63 and -64) (**Figure 4-1**).

Sampling Frequency and Analysis

During 2007, the three J-10 beam stop wells were monitored one time and the samples were analyzed for tritium (**Table 1-6**). Analytical results for 2007 are presented in **Appendix D**.

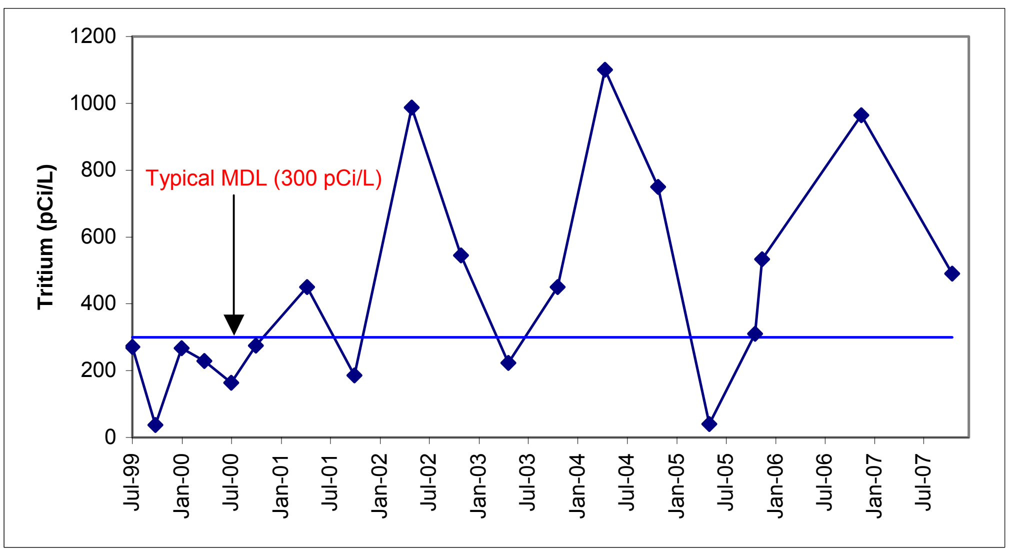
4.1.7.2 AGS J-10 Beam Stop Monitoring Well Results

Since 2001, low levels of tritium have been routinely detected in groundwater downgradient of the J-10 beam stop (**Figure 4-5**). During 2007, the maximum tritium concentration was 490 pCi/L in well 054-63.

4.1.7.3 AGS J-10 Beam Stop Monitoring Program Evaluation

Groundwater monitoring data suggest that the engineered controls in place at J-10 are preventing significant rainwater infiltration into the activated soil shielding. However, the occasional detection of low levels of tritium (up to 1,000 pCi/L), suggests that some rainwater may be infiltrating the activated soil. During 2008, the monitoring frequency for the J-10 Beam Stop area wells will continue to be annual.

Figure 4-5.
Maximum Tritium Concentrations in Wells 054-63 and 054-64,
Downgradient of the J-10 Beam Stop.



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 two magnetic "horns" and collimators immediately downstream of the target. Secondary particles desired for research would be focused by the horns, and other particles would either strike the collimators or be de-focused and enter the surrounding shielding. 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 four temporary wells downgradient of the former U-Line beam stop, which is approximately 200 feet north of the target area. Tritium was detected at concentrations up to 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 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 over the U-Line beam stop area, and two additional permanent wells were installed to provide improved long-term monitoring of this source area.

4.1.8.1 Former AGS U-Line Groundwater Monitoring

Well Network

The former U-Line area is monitored by one upgradient and six downgradient wells. Three of the downgradient wells monitor the target area, and three wells monitor the beam stop area (**Figure 4-1**).

Sampling Frequency and Analysis

During 2007, the former U-Line area wells were monitored one time, and the samples were analyzed for tritium (**Table 1-6**). Analytical results for 2007 are presented in **Appendix D**.

4.1.8.2 Former AGS U-Line Groundwater Monitoring Well Results

U-Line Target Area

Low levels of tritium have been routinely detected in wells downgradient of the former U-Line beam target since monitoring began in 2000 (**Figure 4-6**). The highest tritium concentration during 2007 was 1,980 pCi/L, in well 054-129 located approximately 200 feet downgradient of the target area.

U-Line Beam Stop Area

Since the cap was installed over the former U-line stop in 2000, tritium concentrations in downgradient wells have been well below the 20,000 pCi/L DWS (**Figure 4-7**). During 2007, only a trace level of tritium (280 pCi/L) was detected in one well downgradient of the U-Line target area.

4.1.8.3 Former U-Line Groundwater Monitoring Program Evaluation

Although low levels of tritium continue to be detected downgradient of the former U-Line target, these concentrations are well below the 20,000 pCi/L DWS. Furthermore, the significant decrease in tritium concentrations since 2000 indicates that the impermeable cap has been effective in stopping rainwater infiltration into the residual activated soil. For 2008, the monitoring frequency for the U-line area wells will continue to be annual.

Figure 4-6.
Maximum Tritium Concentrations in Well 054-129, Downgradient of the Former U-Line Beam Target.

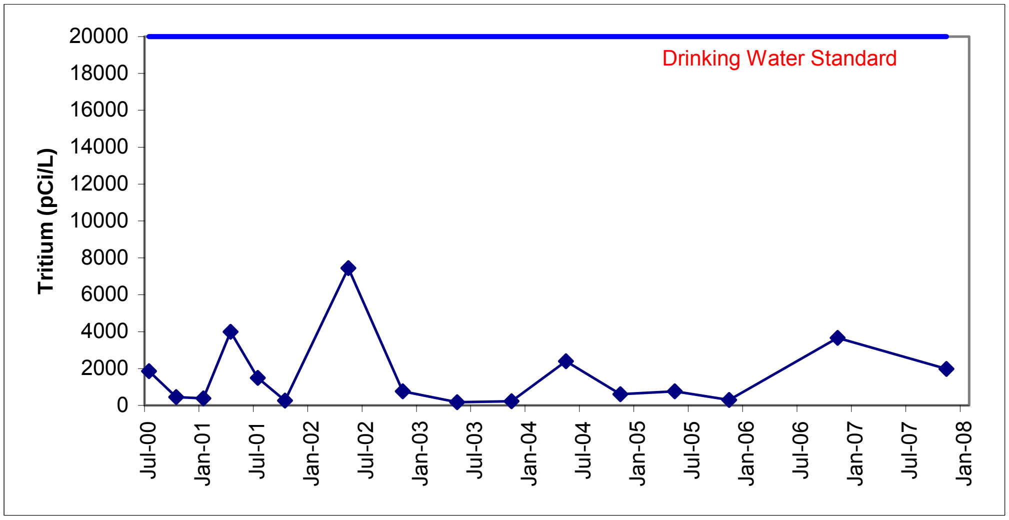
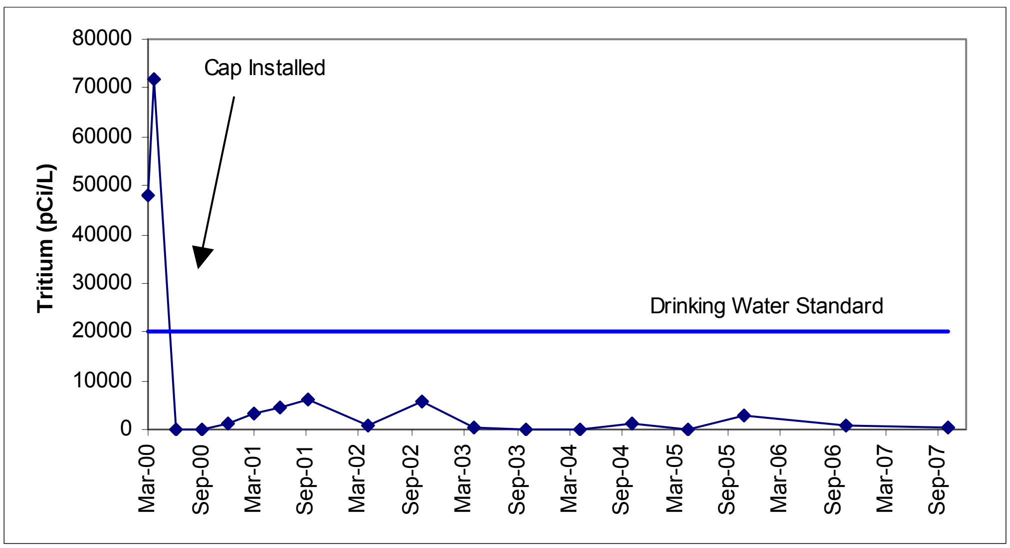


Figure 4-7.
Maximum Tritium Concentrations in Temporary and Permanent Wells Downgradient of U-Line Beam Stop.



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 5 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 Record of Decision (ROD) was signed by the U.S. DOE and U.S. 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 storm water 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 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

Since the discovery of the g-2 tritium plume, BNL has been monitoring the source area surveillance wells quarterly. Monitoring of the downgradient sections of the tritium plume is accomplished using a combination of permanent and temporary wells (**Figures 4-8 and 4-9**).

Sampling Frequency and Analysis

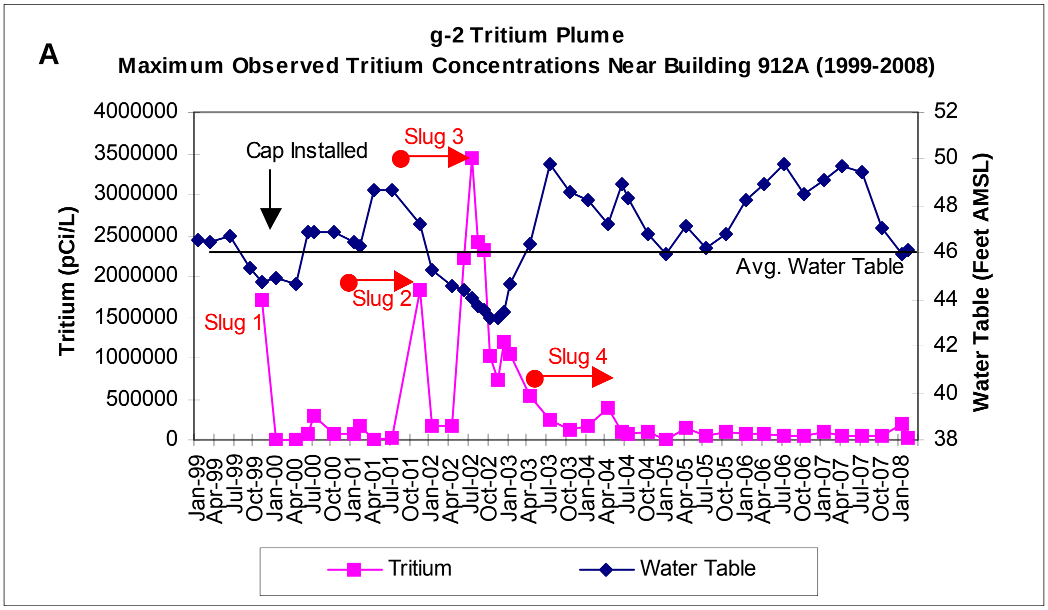
During 2007, the g-2 VQ12 source area monitoring wells were monitored quarterly, and the samples were analyzed for tritium (**Table 1-6**). Analytical results for 2007 are presented in **Appendix D**. The downgradient sections of the tritium plume were monitored using a combination of permanent and temporary wells. The permanent wells located near Building 912 and the AGS parking lot/Waste Concentration Facility areas were sampled three times during the year. From June 2007 to March 2008, 19 temporary wells were installed to track the leading edge of the g-2 tritium plume (**Figure 4-8**). Sample results for the temporary wells are summarized in **Table 4-1**.

4.2.2 g-2 Tritium Source Area and Plume Monitoring Well Results

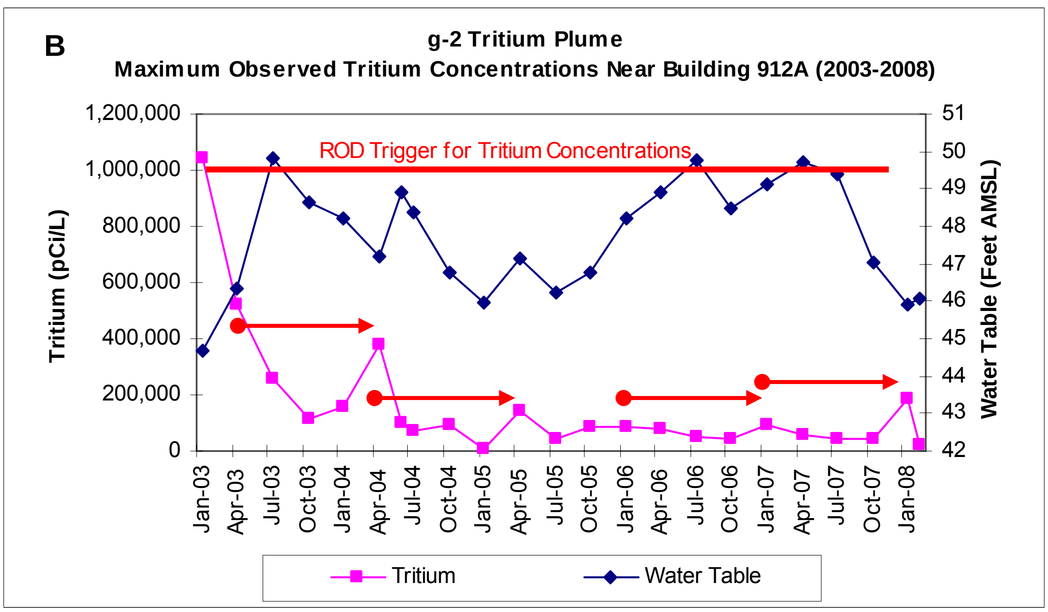
Source Area Monitoring Results

Monitoring data indicate that the high levels of tritium have entered the groundwater as a series of slug releases (**Figure 4-10**). Following the initial releases of tritium that occurred prior to cap installation in December 1999, subsequent periodic slug 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 1 year after each of these periods of high water table elevations, elevated tritium concentrations were observed in the first set of source area surveillance wells. 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 2004, tritium levels in all but two sets of quarterly samples from source area surveillance wells have been less than 100,000 pCi/L. Tritium concentrations were less than 50,000 pCi/L during the second half of 2007, but then increased to 186,000 pCi/L in January 2008 (in well 054-07). Well 054-07 was sampled again in February 2008, and the tritium concentration in the well dropped to 21,800 pCi/L. 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.

Figure 4-10. Maximum Tritium Concentrations Downgradient of the g-2 Tritium Source Area.
A: Maximum tritium concentrations observed during 1999 through 2007 in groundwater downgradient of the VQ-12 source area. Red arrows represent approximately 1 year of travel time from the source area to the first set of downgradient monitoring wells.



B: Comparison of 2003–2007 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 2008 is depicted on **Figure 4-8**. **Figure 4-9** provides a cross-section view of the plume. Monitoring of the downgradient areas of the plume is accomplished using a combination of permanent and temporary wells. During June 2007 through March 2008, 19 temporary wells were installed along four east–west transects (Transects A, B, C and D). The highest tritium concentration was 198,000 pCi/L, observed along Transect B in temporary well GP-73.

This tritium concentration is consistent with g-2 Engineering Evaluation/Cost Analysis (EE/CA) model predictions of decay and dispersion effects on the high concentration plume segments (i.e., slugs) with distance from the source area. Along Transect C located immediately north of the HFBR, the highest tritium concentration was 53,900 pCi/L, in temporary well GP-66. Along Transect D, installed immediately south of the HFBR, the maximum tritium concentration was 83,000 pCi/L in temporary well GP-84. As a result of natural radioactive decay and dispersion in the aquifer, the tritium plume (as defined by concentrations >20,000 pCi/L MCL) appears to be breaking up into discrete segments.

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 VQ12 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 the 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 groundwater table elevation about 1 year before the sampling (**Figure 4-10**). 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. 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.

During 2008, source area monitoring wells will continue to be sampled quarterly. The downgradient sections of the tritium plume will continue to be monitored using a combination of permanent wells near Building 912 and the AGS parking lot, and temporary wells will be used to track the leading segments of the plume. The permanent wells will be monitored semiannually. During the summer of 2008, additional temporary wells will be installed immediately south of the HFBR to track the leading edge of the g-2 plume. To fulfill the monitoring requirements defined in the ROD, BNL will continue to track the plume until the tritium concentrations drop below the 20,000 pCi/L DWS.

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-ft underground tank. The targets rest inside a water-filled 18-in. diameter shaft that runs the length of the tank, and they are cooled by a 300-gal 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 Suffolk County Department of Health Services (SCDHS). The BLIP facility also has a 500-gal underground storage tank (UST) for 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 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 "5 percent" criteria described in the *Accelerator Safety* SBMS (Standards Based Management System) subject area.[2]

Following the concurrence from the NYSDEC, a ROD was signed by the U.S. DOE and U.S. 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 storm water 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 and five downgradient wells. 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 2007, the three wells located immediately downgradient of BLIP were monitored quarterly (wells 064-47,-48, and -67). The two upgradient wells and remaining two downgradient wells were sampled semiannually. All samples were analyzed for tritium, and one set of samples from the three immediately downgradient wells were analyzed for sodium-22 (**Table 1-6**). Analytical results for 2007 are presented in **Appendix D**.

4.3.2 BLIP Monitoring Well Results

Monitoring data collected from January 1999 to July 2000 indicated that the 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 that 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 all of 2001 and 2002. From 2003 through 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 5 percent of the drinking water standard (i.e., >1,000 pCi/L for tritium and 20 pCi/L for sodium-22).

several short-duration periods when tritium concentrations once again exceeded 20,000 pCi/L (**Figure 4-12**). Since January 2006, tritium levels have remained below the 20,000 pCi/L DWS. During 2007, the maximum tritium concentration was 13,100 pCi/L. During the first two sample quarters of 2008, tritium levels have remained less than 2,000 pCi/L.

Figure 4-11.
Maximum Tritium Concentrations in Wells ~ 40 feet Downgradient of the BLIP Target Vessel.

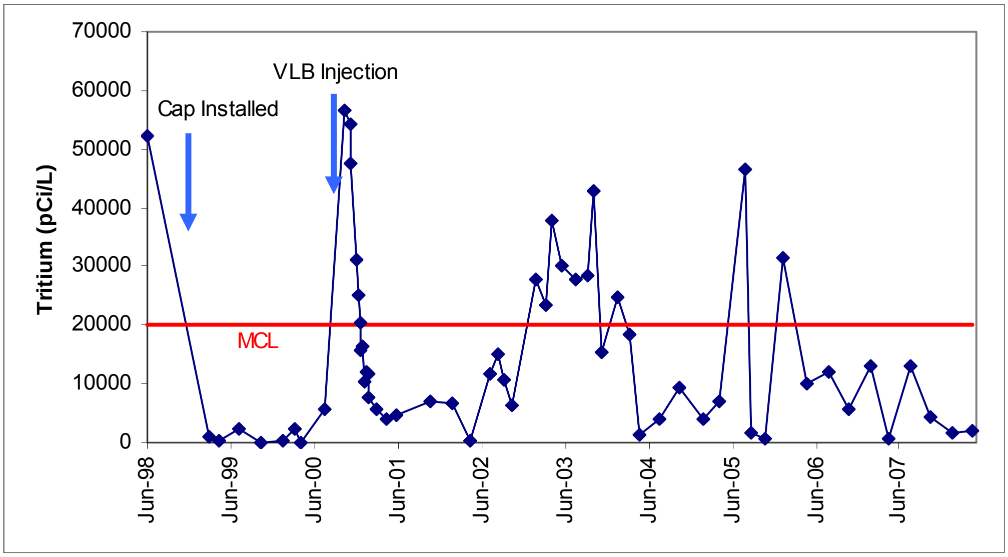
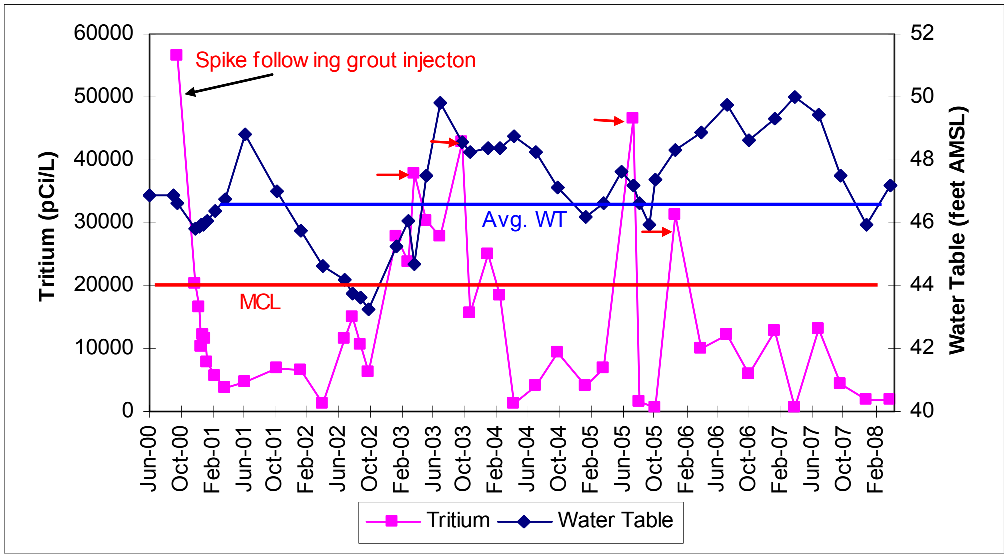


Figure 4-12.
Tritium Concentrations vs. Water Table Position, 40 Feet Downgradient of the BLIP Target Vessel.



Note 1: Arrows indicate approximate groundwater travel time from directly below the BLIP target to the first set of monitoring wells (e.g., well 064-67). Travel time 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 gunite cap, paved areas, and roof drains at BLIP are in good condition and are 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. A comparison of tritium concentrations to changes in water table position suggests that the periodic increases in tritium concentrations are probably associated with seasonal increases in water table elevation (**Figure 4-12**). 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. The short-term concentration increases observed in 2005 and 2006 also appear to be correlated to increases in the position of the water table.

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. Until the tritium levels in groundwater routinely remain below the 20,000 pCi/L DWS, BNL will continue to monitor the BLIP wells quarterly.

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- 13**). 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 the 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 in the collimator area, and one well is downgradient of the W-Line beam stop (**Figure 4-13**). As an extension to the groundwater monitoring program, surface water samples are also collected from the Peconic River both upstream (location HY) and downstream (location HV) of the beam stop area 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 2007, groundwater samples were collected from the RHIC monitoring wells on a semiannual schedule, and the samples were analyzed for tritium (**Table 1- 6**). Analytical results for 2007 are presented in **Appendix D** . Routine analysis for sodium-22 was dropped from the groundwater surveillance 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 analyzed for tritium and sodium-22.

4.4.2 RHIC Monitoring Well Results

As in past years, no tritium was detected in any 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. During 2008, groundwater samples will continue to be collected on a semiannual basis. Surface water samples will also be collected periodically as part of the surveillance 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 Ci of tritium. Unlike the High Flux Beam Reactor, 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 (nonradioactive) 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 4-14**). 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 2 years. The next set of samples will be collected in 2008, and the samples will be analyzed for tritium, gamma emitting radionuclides, gross alpha, and gross beta (**Table 1-6**).

4.5.2 BMRR Monitoring Well Results

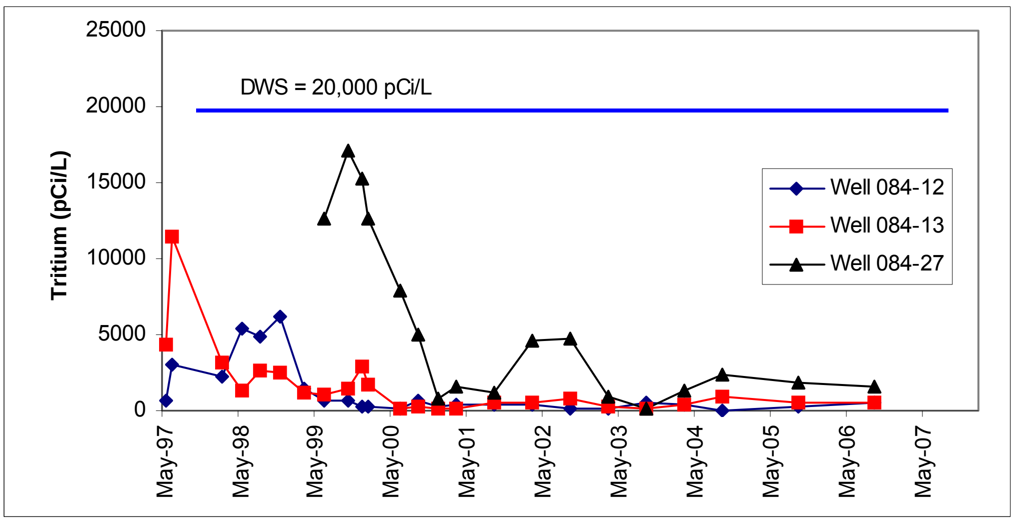
Monitoring results for the last set of samples collected in 2006 indicated that tritium concentrations continued to be well below the 20,000 pCi/L DWS. Detectable levels of tritium were observed in all three downgradient wells, with the maximum value of 1,570 pCi/L detected in well 084-27 (**Figure 4-15**). As in past years, gamma, gross alpha, and gross beta results did not indicate the presence of any other reactor-related radionuclides.

4.5.3 BMRR Groundwater Monitoring Program Evaluation

Tritium concentrations in groundwater have never exceeded the 20,000 pCi/L DWS, and have remained <5,000 pCi/L since 2001. The BMRR structure is effectively reducing rainwater infiltration into the underlying soils, and therefore reducing the movement of any residual tritium from the soil to the groundwater.

Starting in 2007, the monitoring frequency for the BGRR wells was reduced to once every 2 years, with the next set of samples being collected in 2008.

Figure 4-15.
Tritium Concentrations Downgradient of the BMRR from 1997–2007.



4.6 Sewage Treatment Plant (STP)

The Sewage Treatment Plant (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, 1.25 million gallons per day (MGD) are processed during the summer and 0.72 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 the Laboratory with the ability to divert all sanitary system effluent for approximately 1 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 are used to monitor groundwater quality in the filter bed area and three wells are monitored in the holding pond area (**Figure 4-16**).

Sampling Frequency and Analysis

During 2007, the six STP filter bed area wells were monitored semiannually and the three holding pond area wells were sampled annually. The samples were analyzed for VOCs, anions, metals, tritium, gross alpha, gross beta, and gamma emitting radionuclides (**Table 1-6**). Analytical results for 2007 are presented in **Appendix D**.

4.6.2 STP Monitoring Well Results

Radiological Analyses

Radioactivity levels in samples collected from most of the STP wells during 2007 were generally typical of ambient (background) levels. As in previous years, higher than normal gross alpha and gross beta levels were detected in the samples from filter bed area monitoring well 038-02, at maximum concentrations of 93 pCi/L and 109 pCi/L, respectively. This well is screened in fine-grained material above a localized low permeability (silt and clay) deposit, and the elevated gross alpha and gross beta values are believed to be related to the naturally occurring radionuclides common to these deposits. Low levels of tritium were detected in filter bed area wells 039-86 and 039-87, at concentrations of 1,190 pCi/L and 660 pCi/L, respectively. No BNL-related gamma emitting radionuclides were detected in any of the STP groundwater monitoring wells.

Nonradiological Analyses

During 2007, all water quality and most metals concentrations were below the applicable NYS AWQS or DWS. In filter bed area well 039-86 sodium was detected at a concentration of 27 mg/L, slightly above the 20 mg/L NYS AWQS. Low levels of nitrates continue to be detected in many of the STP filter bed area wells, with a maximum concentration of 5.2 mg/L detected in filter bed area 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 2007 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 continue to be highly effective. No changes to the monitoring frequency are proposed for 2008.

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 4-17**). 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 aboveground storage tank used for waste oil, and one 3,000-gal 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 -06) are used to monitor for potential contaminant releases from the UST area (**Figure 4-17**).

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 2007, the UST area wells were monitored semiannually and the samples were analyzed for VOCs (**Table 1-6**). Analytical results for 2007 are presented in **Appendix D**. The wells were also checked for the presence of floating petroleum hydrocarbons during these sample periods. The Building 423/326 area wells were monitored annually, and the samples were analyzed for VOCs.

4.7.2 Motor Pool Monitoring Well Results

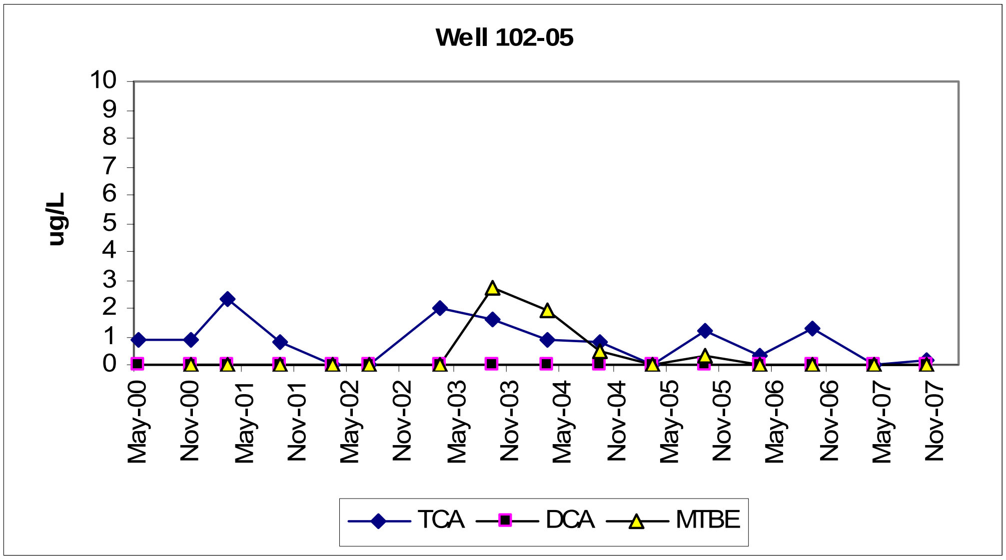
Underground Storage Tank Area

During 2007, no gasoline related products (including MTBE) were detected in groundwater downgradient of the gasoline UST area (**Figure 4-18**). Although MTBE concentrations had reached a maximum of nearly 34 µg/L (the NYS AWQS is 10 µg/L) during 2003, MTBE concentrations decreased to non-detectable levels by 2006. As in past years, low levels of the solvent TCA were also detected, but at concentrations that continued to be well below the NYS AWQS of 5 µg/L. Wells 102-05 and 102-06 were also tested for the presence of floating petroleum hydrocarbons. As in previous years, no floating product was observed.

Building 423/326 Area

For the first time in 7 years of groundwater surveillance in this area, all concentrations of the solvents TCA and DCA decreased to less than their applicable NYS AWQS (**Figure 4-19**). Levels of the former gasoline additive MTBE has been less than the 10 µg/L NYS AWQS since 2005. It is believed that the TCA, DCA, and MTBE originated from historical vehicle maintenance operations.

Figure 4-18.
VOC Concentration Trends Downgradient of the Gasoline UST Area.



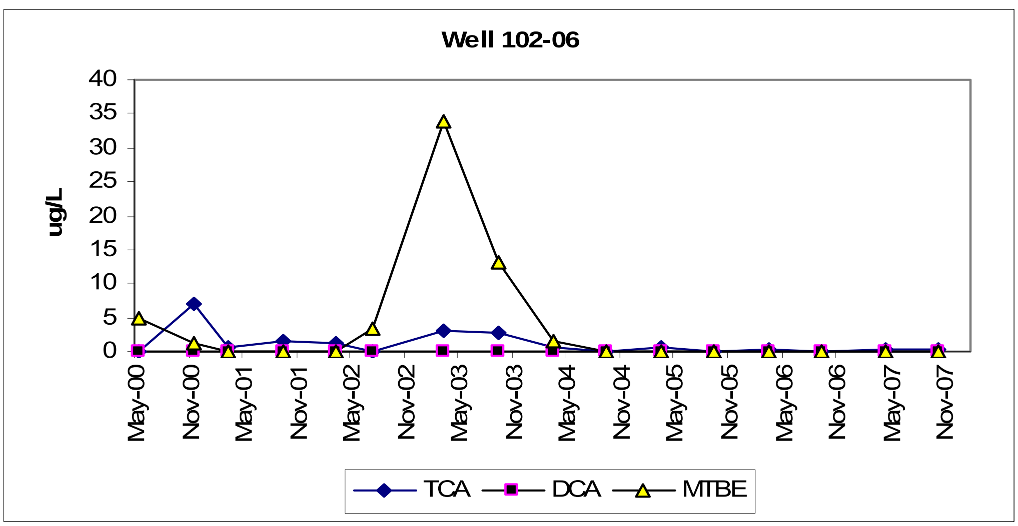
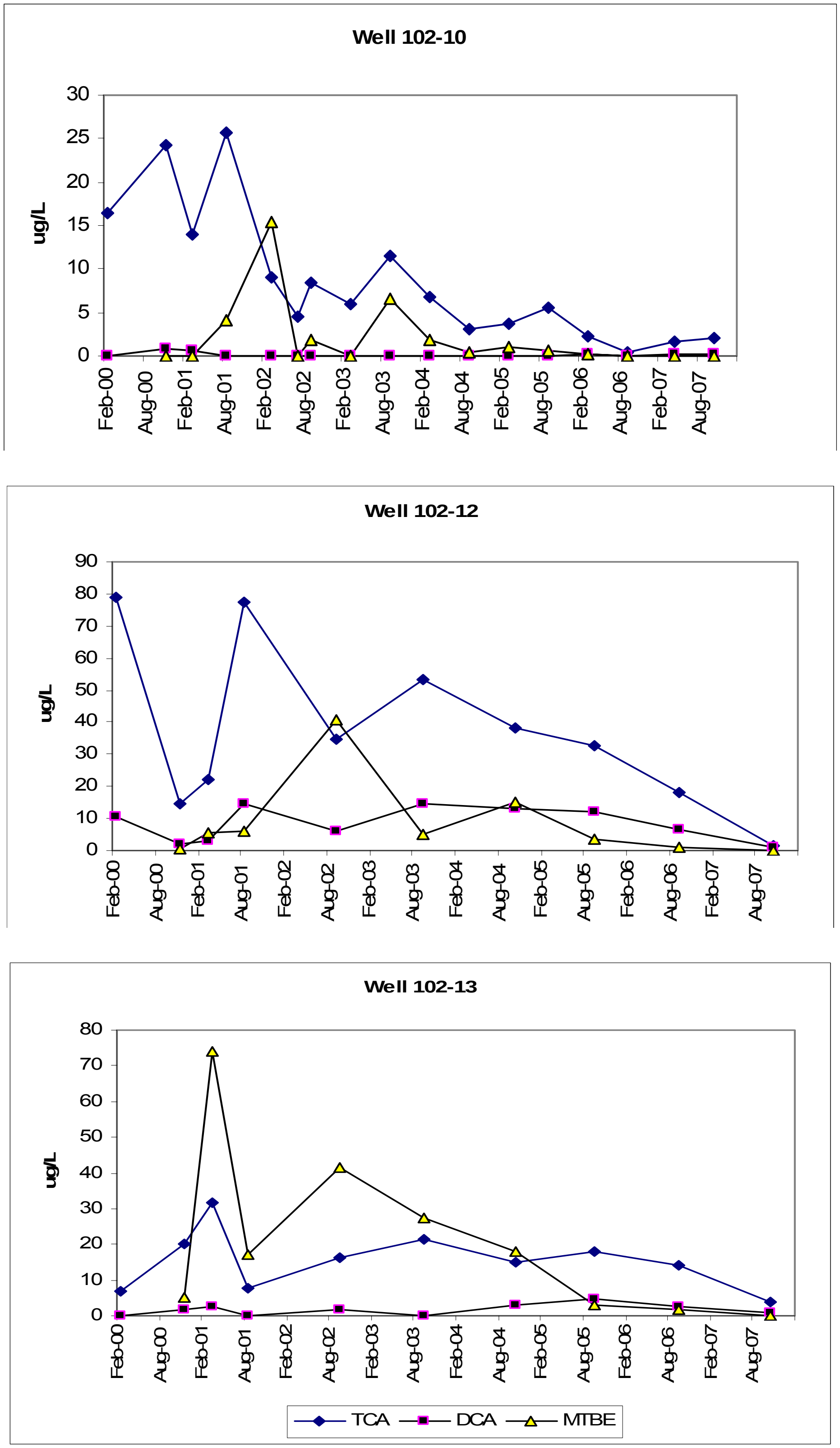


Figure 4-19.
VOC Concentration Trends in Wells Downgradient of Building 323/326.



4.7.3 Motor Pool 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 2007 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 is likely to have originated from historical spills. No changes to the monitoring program are proposed for 2008.

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-gal and two 8,000-gal tanks for storing gasoline, and one 500-gal 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-gal USTs for storing unleaded gasoline, and one 500-gal 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 (see **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 4-20**).

Sampling Frequency and Analysis

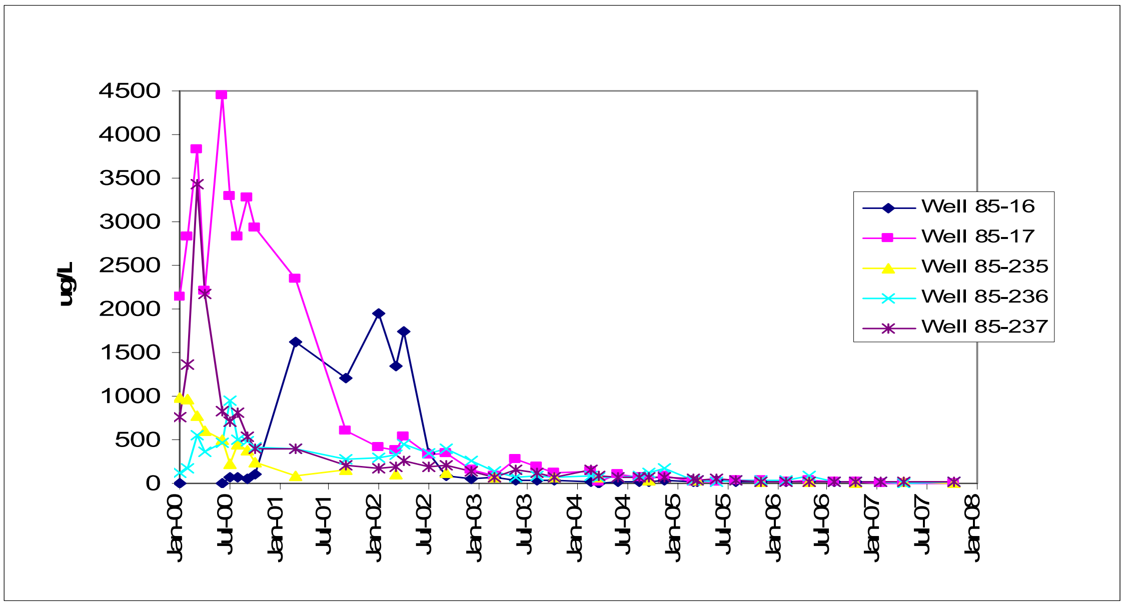
During 2007, the service station facility wells were monitored three times, primarily by the LTRA program as part of the Carbon Tetrachloride plume monitoring project. The samples were analyzed for VOCs (**Tables 1-5 and 1 -6**). Analytical results for 2007 are presented in **Appendix D**. Three of the 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 2007, carbon tetrachloride (and its breakdown product, chloroform) continued to be observed in the service station monitoring wells (**Figure 4-21**). The maximum carbon tetrachloride and chloroform concentrations were 24 µg/L and 16 µg/L, respectively. The levels of carbon tetrachloride currently detected in the groundwater is 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 (see **Section 3.2.1**), which achieved its cleanup objectives and was shut down in August 2004.

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 2007, high levels of VOCs were detected in well 085-17 during the October sample round, with total xylenes detected at 140 µg/L, ethylbenzene at 15 µg/L, 1,2,4-trimethylbenzene at 35 µg/L, and the solvent PCE at a concentration of 14 µg/L (**Figure 4-22**). Compared to 2006, there was a significant drop in VOC concentrations in well 085-236, to nearly non-detectable levels (**Figure 4-23**). VOC levels remained nearly non-detectable in well 085-237 (**Figure 4-24**). As in previous years, no floating product was detected in the wells.

Figure 4-21.
Carbon Tetrachloride Concentration Trends in Service Station Monitoring Wells.



4.8.3 Service Station Groundwater Monitoring Program Evaluation

Analysis of groundwater samples collected at the service station facility during 2007 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. No changes to the monitoring program are proposed for 2008.

Figure4-22.
Downgradient Well 085-17: Trend of Service Station-Related VOCs. Carbon tetrachloride originating from the upgradient carbon tetrachloride UST source area is not included.

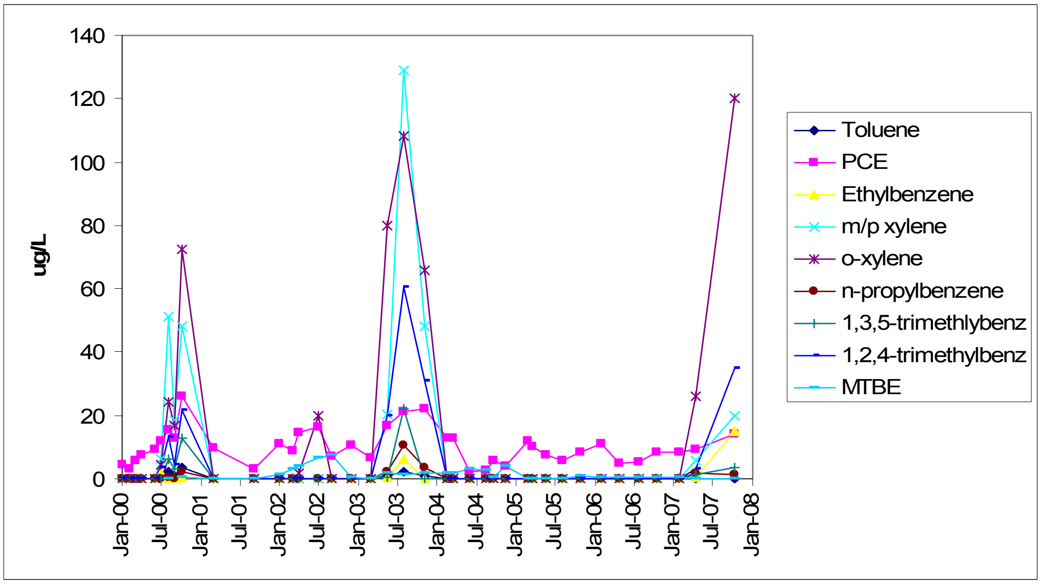


Figure 4-23.
Downgradient Well 085-236: Trend of Service Station-Related VOCs. Carbon tetrachloride from the upgradient carbon tetrachloride UST source area is not included.

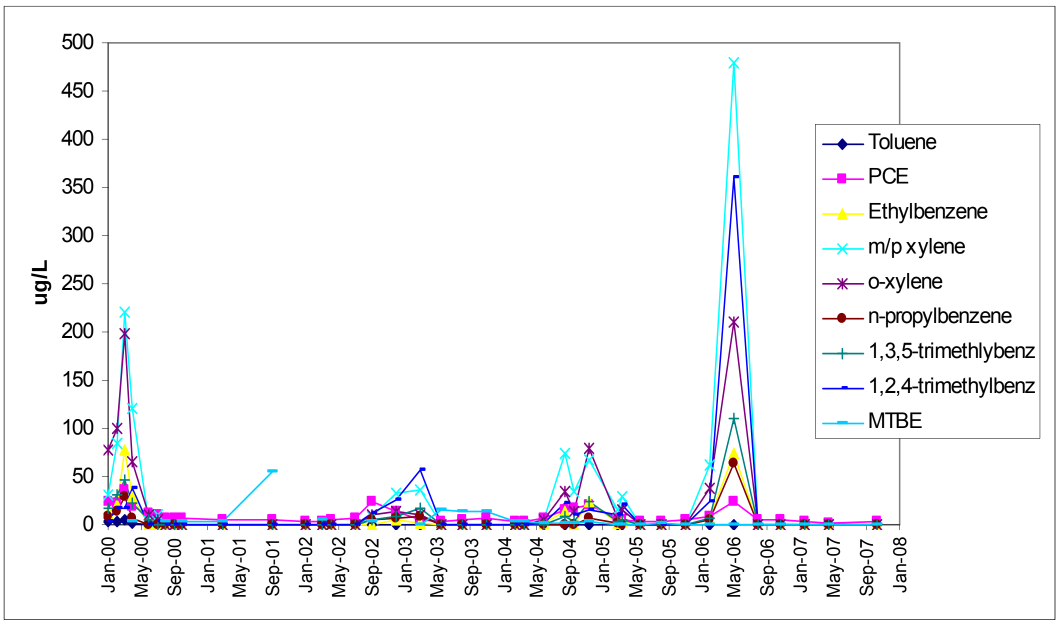
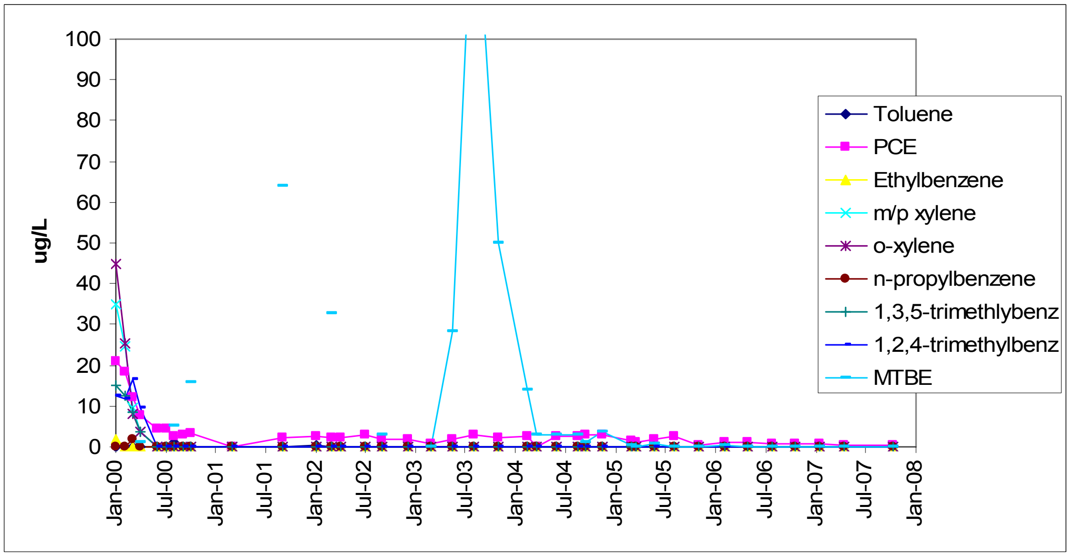


Figure 4-24. **Downgradient Well 085-237: Trend of Service Station-Related VOCs.** Carbon tetrachloride originating from the upgradient carbon tetrachloride UST source area is not included.



4.9 Major Petroleum Facility Area

The Major Petroleum Facility (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 aboveground 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 aboveground pipelines that have secondary containment and leak detection devices. All of 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™ (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, all 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 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 Interagency Agreement (see **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 4-25**).

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 Environmental Surveillance 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. Analytical results for 2007 are presented in **Appendix D**.

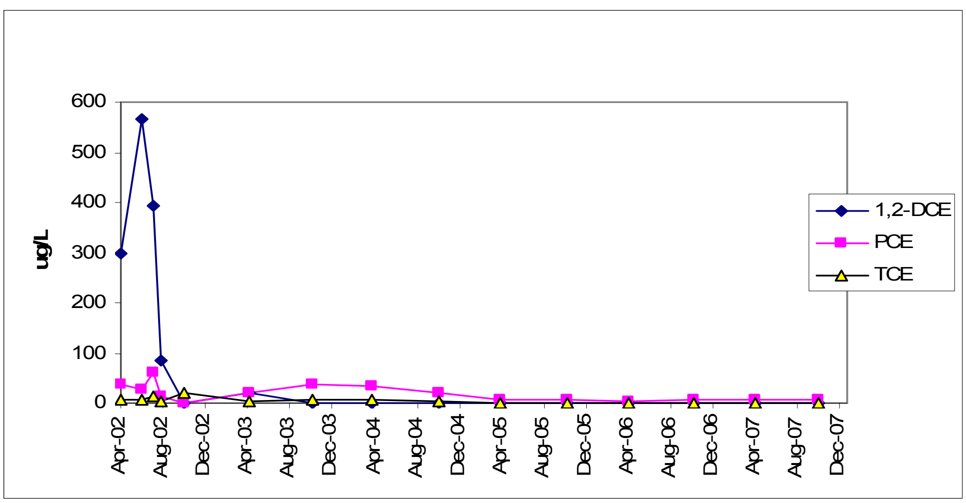
4.9.2 MPF Monitoring Well Results

BNL sampled the MPF wells in April and October 2007. The wells were also tested monthly for the presence of floating petroleum. The samples were tested for SVOCs and VOCs. As in the past, no SVOCs were detected, and no floating product was observed. Trace to low levels of TCA (up to 0.8 μg/L), tetrachloroethylene (up to 6.5 μg/L), and chloroform (up to 1.2 μg/L) continued to be detected in upgradient well 075-25. These compounds are related to historical spills near building 650. As in past years, several solvents continued to be detected in downgradient well 076-380. Trace levels of TCA and TCE were detected (<1 μg/L), and PCE was detected at concentrations up to 7.9 μg/L, slightly above NYS AWQS of 5 μg/L. Levels of the PCE breakdown product trans-1,2-dichloroethene dropped to non-detectable levels by the end of 2005, and remained at non-detectable levels during all of 2006 and 2007 (**Figure 4-26**). 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 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 originated from historical solvent spills near Building 610. 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) trans-1,2-dichloroethene is a breakdown product of PCE. 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. For 2008, monitoring will continue as required by the NYS operating permit.

Figure 4-26.
VOC Concentrations Downgradient of the Major Petroleum Facility, in Well 076-380.



4.10 Waste Management Facility (WMF)

The Waste Management Facility (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 Waste 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

Eight wells are used to monitor groundwater quality near the WMF (**Figure 4-27**). Three wells are used to assess background water quality, and five wells are positioned downgradient of the three waste handling and storage buildings. When the monitoring wells were originally installed in the mid 1990s, groundwater flow directions in the WMF area were predominantly to the north–northeast; with flow directions being strongly influenced by a groundwater mound below Basin HO (located immediately south of the WMF) and water pumpage from supply wells 11 and 12 (located immediately to the north). Subsequent water conservation efforts have resulted in significant reductions in water supply pumpage from wells 11 and 12 and reduced recharge at Basin HO. When supply wells 11 and 12 are not in operation, the groundwater flow direction in the WMF area is predominantly to the southeast. To effectively use the existing monitoring wells, supply wells 11 and 12 are operated continuously for a 2-week period prior to sampling the monitoring wells, in order to establish the necessary northward flow patterns. A complete set of monitoring data and groundwater flow maps are provided in the *2007 Groundwater Monitoring Report for the Waste Management Facility* (BNL 2008c).

Sampling Frequency and Analysis

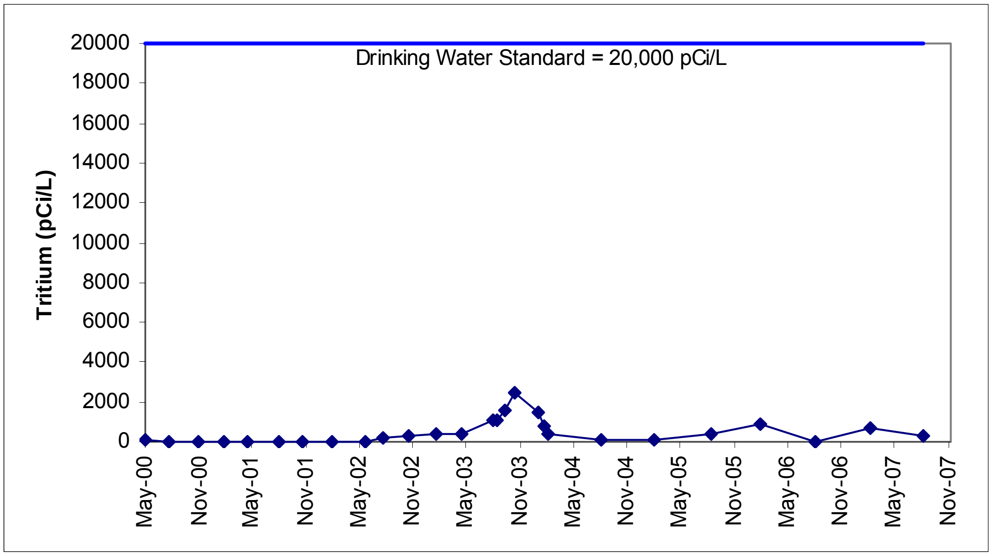
During 2007, the WMF wells were sampled in February and August. Groundwater samples were analyzed twice for VOCs, tritium, gamma spectroscopy, gross alpha, and gross beta, and one time for metals and anions (e.g., chlorides, sulfates, and nitrates) (**Table 1-6**). Analytical results for 2007 are presented in **Appendix D**.

4.10.2 WMF Monitoring Well Results

Radiological Analyses

Gross alpha and beta concentrations in samples from both upgradient and downgradient monitoring wells are consistent with background concentrations, and no BNL-related gamma-emitting radionuclides were identified. As in past years, a trace level of tritium (660 pCi/L) was detected in Reclamation Building area monitoring well 056-23 (**Figure 4-28**). In October 2007, a trace level of tritium (700 pCi/L) was detected in nearby supply well 12.

Figure 4-28.
Tritium Concentration Trends in Well 056-23,
Downgradient of Waste Management Facility.



Nonradiological Analyses

All anions (chlorides, sulfates, and nitrates) and most metals concentrations were below applicable NYS AWQS. As in past years, sodium continued to be detected above the 20 mg/L NYS AWQS in a number of upgradient and downgradient wells, with a maximum concentration of 32 mg/L detected in downgradient well 056-22. The elevated sodium concentrations are likely due to road salting operations. During 2007, no VOCs were detected at concentrations above NYS AWQS. Low levels of chloroform continued to be detected in many of the WMF wells, with the highest level of 1.3 µg/L detected in upgradient well 066-83, which is located close to recharge basin HO. Because this basin receives secondary cooling water that was supplied from the potable water system, it is likely that the chloroform detected in the WMF monitoring wells is a chlorination by-product. A trace level of TCA (0.13 µg/L) was detected in downgradient well 066-84. The NYS AWQS for TCA and chloroform are 5 µg/L and 7 µg/L, respectively.

4.10.3 WMF Groundwater Monitoring Program Evaluation

Groundwater monitoring results for 2007 were consistent with previous years' monitoring, and continued to show that WMF operations were not affecting groundwater quality. There were no outdoor or indoor spills at the facility that could have impacted soil or groundwater quality. Except for sodium detected in one well, all chemical and radionuclide concentrations were below NYS AWQS or DWS. 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.

For 2008, monitoring will continue as required by the RCRA Part B Permit. In late 2007, five new downgradient groundwater monitoring wells were installed at the WMF. The new wells were positioned downgradient of the buildings based on the current southeast groundwater flow direction. As a result, supply wells 11 and 12 will not have to be operated continuously for a two-week period prior to sampling the monitoring wells. These new wells will be incorporated into the monitoring program starting in February 2008. The older wells will be maintained for the collection of water level data, and the possible future collection of groundwater samples.

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 to groundwater quality of such a release, BNL installed a new surveillance well immediately downgradient of the building and monitored several nearby wells.

4.11.1 Building 801 Groundwater Monitoring

Well Network

From May through October 2002, three existing downgradient wells were sampled. 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 (see **Figure 3.2.15**). 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. Because well 065-37 is not ideally screened at the water table to properly monitor a nearby contaminant source area, a new shallower well, 065-325, was installed in early October 2002.

Sampling Frequency and Analysis

During 2007, Building 801 monitoring well 065-325 was sampled two times under the Environmental Surveillance Program (**Table 1-6**). Analytical results for 2007 are presented in **Appendix D** . The samples were analyzed for gross alpha, gross beta, Sr-90, Cs-137, and tritium. Monitoring wells 065-37, -169, and -170 were sampled one to two times under the LTRA program, and the samples were analyzed for Sr-90 and Cs-137 (**Table 1-5**).

4.11.2 Building 801 Monitoring Well Results

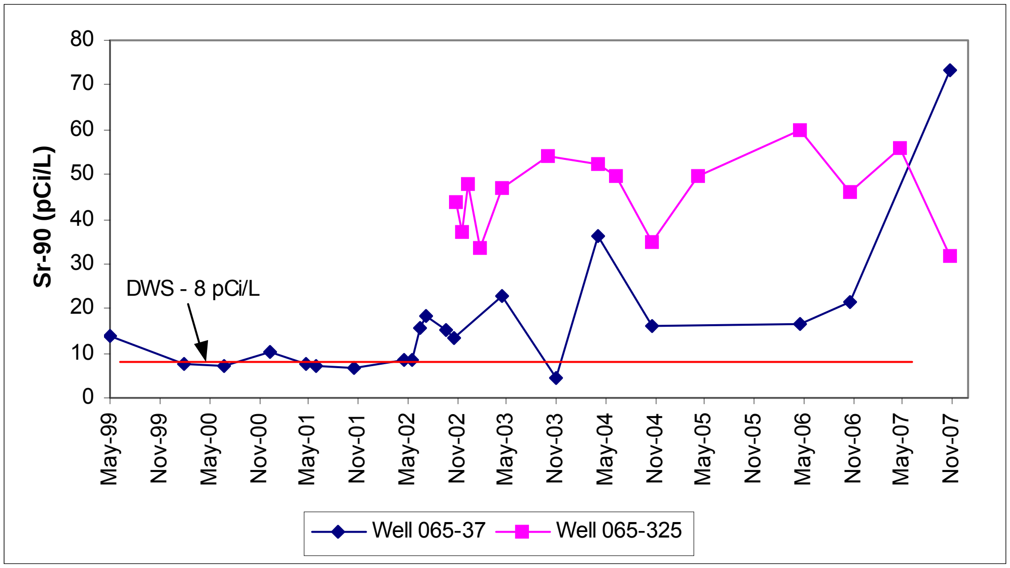
The April and October 2007 samples from well 065-325 had Sr-90 concentrations of 56 pCi/L and 31.7 pCi/L, respectively (**Figure 4-29**). Cs-137 was not detected in any of the samples. Sr-90 concentrations in the slightly deeper well 065-37 increased from 21.3 pCi/L in 2006 to 73.3 pCi/L in October 2007. Only low levels of Sr-90 were detected in deeper wells 065-169 and 065-170, with maximum concentrations of 1.3 pCi/L and 1.2 pCi/L, respectively.

4.11.3 Building 801 Monitoring Program Evaluation

Sr-90 concentrations in samples collected during 2007 from shallow groundwater well 065-325 are consistent with pre-December 2001 values. Additionally, Cs-137 has not been detected in any of the groundwater samples. It is estimated that it could take approximately 3 to 8 years for Sr-90, and approximately 100 years for Cs-137, from the December 2001 Building 801 floodwater release 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 or the nearby former Pile Fan Sump (see **Section 3.2.15**).

The monitoring frequency for well 065-325 for 2008 will continue to be semiannual, and the monitoring will be conducted as close as possible with planned semiannual sampling of wells 065-37, 065-169, and 065-170 by the LTRA program.

Figure 4-29.
Sr-90 Concentration Trends in Downgradient Wells 065-37 and 065-325 at Building 801.



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5.0 SUMMARY OF RECOMMENDATIONS

This section, a summary of all of the recommendations from Sections 3 and 4, is provided as a quick reference. The recommendations are sequenced as they appear in Sections 3 and 4.

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:

- Based on TVOC concentration increases in upgradient plume core well 107-40 the leading edge of the high concentration segment of the VOC plume is approaching the south boundary and should arrive in the near future. As a result, full-time operation of extraction wells EW-1 and EW-2 will continue until further notice.
- Install a vertical profile well approximately 500 feet north of well 107-40 along the Princeton Avenue Firebreak Road to locate the centerline of the VOC high concentration slug. Install a monitoring well if TVOCs are greater than 50 µg/L.
- The routine operation and maintenance monitoring frequency implemented in the fourth quarter of 2004 should be continued. Plume core and perimeter wells are monitored on a semiannual frequency. Sentinel and bypass wells are sampled at a quarterly frequency. Maintain a quarterly sampling frequency for well 107-40 to monitor the hot spot.
- Reduce frequency of Sr-90 sampling for wells 107-34, 107-35, 108-43, 108-44, 115-41, and 115-42 from quarterly to semi-annually, due to the absence of Sr-90 in these wells. Drop Sr-90 analysis for all other off-site wells due to absence of Sr-90. Reduce tritium sampling in bypass wells 115-41 and 115-42 from quarterly to semi-annually.

5.2 Carbon Tetrachloride Pump and Treat System

The following are recommendations for the OU III Carbon Tetrachloride Groundwater Remediation System and monitoring program:

- Maintain the system in standby mode. If significant concentrations of carbon tetrachloride are detected in monitoring or extraction wells, the system will be turned on.
- Move monitoring well 095-92 to the Middle Road Pump and Treat System well network.
- Perform two to four temporary wells in the center of the plume north of extraction well EW-15 and south of well 85-17. These data will be used to help perform the recommended modeling evaluation below.
- Perform groundwater modeling to evaluate if the remaining levels of contaminants in this area can meet the cleanup objectives through natural attenuation. If it can be demonstrated by the model that the current levels will achieve these objectives, then a petition for closure of this system will be submitted to the regulators.

5.3 Building 96 Air Stripping System

The following are recommendations for the OU III Building 96 groundwater remediation system and monitoring program:

- In the spring of 2008 implement the modification to recirculation well RTW-1 to work as a pumping well with Cr(VI) treatment, and discharge to the nearby surface drainage culvert. In addition to the existing air stripping treatment for VOCs, this will involve the installation of ion-exchange treatment vessels for Cr(VI), and running a discharge line to the culvert about 300 feet away. Effluent sampling frequency will be performed as per the approved SPDES equivalency permit. Once Cr(VI) concentrations drop below allowable discharge levels and all monitoring wells in the vicinity of the pumping well are below these levels, treatment for chromium will be eliminated.

- Continue monitoring well sampling at the current quarterly frequency, and add total Cr and Cr(VI) to the analysis.
- Maintain operation of downgradient recirculation wells RTW-2, RTW-3, and RTW-4. Continue operation until TVOC concentrations <50 µg/L are seen in the recirculation wells' influent and adjacent monitoring wells. Maintain a monthly sampling frequency of the influent and effluent for each well when they are operating. When in standby mode reduce the sampling to quarterly.
- In the spring of 2008, perform soil borings at the location of the highest VOC contamination and analyze the silt zone soil cores for VOCs. Geophysical logs and soil cores will be obtained to determine detailed lithology. These data will aid in precisely defining the nature and extent of the source area, which is critical to determine the most cost-effective remedial alternative for this area. In addition, one well will be installed to help evaluate the effectiveness of using soil vapor extraction technology in this area.
- Following the collection of the source area analytical and geological data, complete an evaluation of alternative methods for remediating the contamination in the silt zone upgradient of extraction well RTW-1. This evaluation will include excavation of the source area, adding an additional extraction well in the source area, and evaluating other remedial technologies. The evaluation will be prepared in 2008.
- Following the determination of the remedial action to address the VOCs in the silt zone, update the project DQOs.
- Add a core monitoring well west of well 095-172 to determine VOC concentrations just upgradient of RTW-2.

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 began in 2003.
- Maintain extraction wells RW-4, RW-5, and RW-6 in standby mode during 2008. Restart the wells if extraction or monitoring well data indicate that TVOC concentrations exceed the 50 µg/L capture goal.
- Install a temporary well about 100 feet to the west of well 113-09 to confirm the western edge of the OU III plume in this area. Based on the results of this temporary well, additional sampling or another permanent monitoring well may be required.
- Install a temporary well several hundred feet upgradient of RW-1 to locate a permanent well(s) in this area to provide for monitoring of VOCs migrating toward 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 the routine operations and maintenance monitoring frequency that began in 2003.
- Maintain wells EW-6, EW-7, EW-8 and EW-12 in standby mode. All 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.

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:

- Based on increasing TVOC concentrations (i.e., >20 µg/L) in core well 126-11 in 2007, return extraction well WSB-1 to on full-time operation. Continue pulse pumping 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 starts showing increasing trends, the need to take further action will be evaluated.
- As there have been no detections of VOCs exceeding NYS AWQS for plume perimeter wells 119-03 and 125-01 since they were installed in 2002, VOC analysis will be discontinued. These wells monitor the groundwater quality in the vicinity of the OU III Western South Boundary recharge basin. Also, since background well 124-02 has not had any detections of VOC above the NYS AWQS, this parameter will be dropped.
- 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 2008.
- The system will continue operations at 60 gpm per well except for well UVB-1, which is to remain in a standby mode. It is recommended that well UVB-4 be placed back in operation to address VOCs being observed in monitoring well 000-262, which is located between UVB-4 and UVB-5. Monthly recovery well sampling will continue, and if TVOC concentrations greater than 50 µg/L are observed, well UVB-1 will be restarted.

5.8 Industrial Park East Pump and Treat System

The following are recommendations for the Industrial Park East Pump and Treat System and groundwater monitoring program:

- Continue pulse pumping for one year and if in November 2008 no rebound is seen (i.e., TVOC concentrations exceeding 50 µg/L) in extraction or monitoring wells, then petition for shutdown of this system.

5.9 North Street Pump and Treat System

The following is recommended for the North Street Pump and Treat System and groundwater monitoring program:

- Maintain the operations and maintenance sampling frequency for monitoring wells initiated in 2006.
- Eliminate the Sr-90, gamma spectroscopy, and gross alpha/beta analysis for monitoring well samples due to the absence of any detections for radionuclides over the past several years.

5.10 North Street East Pump and Treat System

The following is recommended for the North Street East Pump and Treat System and groundwater monitoring program:

- Maintain the routine operations and maintenance monitoring frequency for the monitoring wells that began in third quarter 2006. However, plume core wells 000-481, 000-482, 000-483, and 000-484 should be maintained at the quarterly sampling frequency since they are immediately upgradient of extraction well NSE-2.
- Delete Sr-90, gross alpha/beta, and gamma spectroscopy from the analyte, list since there have been no detections above the standards.
- Continue pulse pumping of both extraction wells, since the system influent concentrations have remained very low over the past two years and all of the monitoring wells are already below the capture goal of 50 μg/L TVOC. The pulse pumping consists of having the system on for one month, then off in standby mode for the next month. The extraction well sampling frequency will change from a monthly schedule to only sampled during the months the system is in operation (every other month) If concentrations above the capture goal of 50 μg/L TVOCs are observed in either the core monitoring wells or the extraction wells, the well(s) will be put back into full-time operation. If no rebound is observed in 2008, then petition for shutdown of the system.
- As of the first quarter 2008, lower the pump location four feet in monitor wells 000-482, 000-483, and 000-484 to obtain data from a slightly deeper portion of the aquifer.

5.11 LIPA/Airport Pump and Treat System

The following are recommendations for the LIPA/Airport Groundwater Treatment System and groundwater monitoring program:

- The extraction well sampling will be reduced from monthly to quarterly, except for the LIPA well EW-4L and Airport wells RTW-1A and 6A.
- Continue the airport extraction wells pulse-pumping of one week per month except for wells RTW-1A and 6A, which will continue with full-time operations. Pump well RTW-3A full time to intercept any VOCs migrating from the area of upgradient wells 800-99 and 800-106. If concentrations above the capture goal of 10 μg/L TVOCs are observed in any of the other 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 in either the plume core monitoring wells or the extraction wells, greater than the 50 μg/L capture goal.
- Change well 800-96 from monthly to a quarterly sampling schedule since the new extraction well, EW-6A, is in operation.
- Install a temporary well 200 feet to the west of well RTW-3A and followup with permanent monitoring well(s). This will be done to confirm the location of the western edge of the plume currently seen in upgradient monitoring wells 800-90 and 800-92.

5.12 Magothy Monitoring

No changes to the monitoring program are warranted at this time.

5.13 Central Monitoring

No changes to the monitoring program are warranted at this time.

5.14 Off-Site Monitoring

No changes to the monitoring program are warranted at this time.

5.15 South Boundary Radionuclide Monitoring Program

No changes to the monitoring program are warranted at this time.

5.16 BGRR/WCF Strontium-90 Treatment System

The following are recommendations for the BGRR/WCF groundwater treatment system and monitoring program:

- Install additional temporary wells during the fourth quarter of 2008 in the area of the high Sr-90 detected in late 2007 from the WCF plume near the HFBR. Also, continue to analyze select temporary wells for Sr-90 during their installation just near the HFBR in 2008 for the g-2 tritium plume. These data will be important both to track the hot spot Sr-90 concentrations as well as to determine when the high concentration portion of the g-2 tritium plume has migrated south of this area. This will allow for additional Sr-90 extraction and treatment. These are necessary to obtain sufficient data to accurately define the extent of the high concentration Sr-90 slug and design additional extraction wells.
- Install additional Sr-90 extraction wells to address the Sr-90 hot spot identified in the WCF plume. The modification to the existing Sr-90 treatment system will consist of several new extraction wells. The location and exact number of wells will depend on the distribution of the hot spot following the departure/attenuation of the g-2 tritium slug from this area. It is currently estimated that the modification will be implemented in late 2009/early 2010. Groundwater characterization over the next couple of years will determine the implementation time.
- Supplement existing sentinel monitoring wells along Temple Place as necessary to track the leading edge of the WCF Sr-90 plume. This will be determined based on the results of temporary wells to be installed during the second quarter of 2008.
- For the BGRR plume, install temporary wells near 075-670 and 075-671 to determine the width of the downgradient portion of the plume.
- Raise the pump in BGRR plume core well 075-664 four feet to evaluate Sr-90 concentrations in a shallower portion of the aquifer.
- The monitoring well sampling frequency will be implemented in a phased approach starting in 2009:
  - Change the frequency from startup (semi-annual) to the operations and maintenance phase (annually) for the BGRR and PFS plumes.
  - Due to the additional extraction wells planned to be installed for the WCF plume in 2009/2010, the monitoring well frequency for this plume should remain at the startup phase.

- Maintain the southerly groundwater flow direction by managing the pumping of the BNL supply wells, via the oversight of the BNL Water and Sanitary Planning Committee.

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-2 and EW-3 between 5 to 7 gpm.
- Due to the low influent concentrations, implement pulse pumping of EW-1 (cycle of 1 month on, 1 month off) beginning in January 2008. If concentrations in this extraction well increase significantly, then EW-1 will be put back into full-time operation
- Due to the increase of Sr-90 concentrations in monitoring well 106-16, install temporary wells upgradient of this location to verify that there is no continuing source of contamination. This work will be performed in mid 2008. Based on a review of the data, a monitoring well may also be installed.
- Maintain the operations and maintenance phase monitoring well sampling frequency started in 2007. Change the frequency for the five new monitoring wells from quarterly to semi-annually. Also, change the sampling frequency for well 106-99 from annual to semi-annual.
- Starting in the third quarter of 2008, drop VOC analysis from the monitoring wells, since VOCs have not been detected above the DWS since 2004.
- Transfer monitoring wells 106-20, 106-21, 106-43, 106-44, 106-45, and 106-64 to the Former Landfill groundwater monitoring program. The data will be discussed in the annual *Landfill Monitoring Report*.

5.18 HFBR Tritium Pump and Recharge System

The following are recommendations for the HFBR tritium Pump and Recharge System and monitoring program:

- Continue the monitoring well sampling schedule initiated in 2006.
- Continue to install and sample temporary wells twice per year over the next several years to characterize the location of the high tritium concentration area, and results will be communicated to the regulators via the IAG conference call and quarterly/annual reports.
- Continue operating EW-16 and EW-11 in 2008. Monitor tritium concentrations in EW-16 on a monthly basis.
- The pump and recharge well(s) will be operated until the tritium concentrations in the wells in the area of Weaver Drive to the new extraction well drop below 20,000 pCi/L. The estimated operational duration of 2 to 4 years is based on the length of the high concentration area slug and the time it would take to be completely captured by the new extraction well. The decision to turn the wells back to standby will be based on; 1) 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 2) verification that the new extraction well has captured concentrations of tritium in this area greater than 20,000 pCi/L. This 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

The following are recommendations for the OU IV AS/SVE Post Closure Monitoring program:

- Reduce frequency of sampling from semiannual to annual due to the lack of detections of VOCs and SVOCs.

5.20 Building 650 (Sump Outfall) Strontium-90 Monitoring

The following recommendation is made for the Building 650 Strontium-90 Groundwater Monitoring Program:

- Reduce the sampling frequency for monitoring wells 076-25, 076-26, 076-314, 076-317, 076-373, 066-189, and 066-190 to annual. There have been no significant detections of Sr-90 in these wells over the past several years. Several of these wells (076-314, 066-189, and 066-190) are no longer downgradient of the source area due to changes in groundwater flow resulting from the diminished water table mounding at Basin HO. The sampling frequencies can be increased if warranted by future changes in groundwater flow conditions.

5.21 Operable Unit V

The following recommendation is made for the OU V plume groundwater monitoring program:

- Due to the low concentrations of perchlorate being detected, reduce the frequency of this analysis from semi-annual to annual for the eight monitoring wells.

5.22 Operable Unit VI Pump and Treat System

The following recommendations are made for the OU VI EDB Pump and Treat System and groundwater monitoring program:

- Add another plume bypass well east of well 000-508 and slightly deeper, to verify that EDB is being captured by extraction well EW-2E.
- Maintain the routine operation and maintenance monitoring frequency that began in third-quarter 2006.
- Since there were no detections above the DWS for EDB in well 000-498 for 2006 and 2007, change the sampling frequency for this well from quarterly (system start-up phase) to semi-annually (O&M phase). Also change the frequency for on-site wells 058-02, 089-13, 089-14, 099-06, 099-10, 099-11, 100-12, 100-13, and 100-14 to annual, since there have been no detections of EDB above the federal DWS since mid 2003.

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 monitoring program are warranted at this time.

5.25 Former Landfill Groundwater Monitoring

No changes to the monitoring program are warranted at this time.

5.26 Alternating Gradient Synchrotron (AGS) Complex

In accordance with g-2/BLIP/UST ROD requirements, BNL will continue to monitor groundwater quality downgradient of g-2 source area until the source is no longer a threat to groundwater quality. Furthermore, the downgradient sections of the g-2 plume will be monitored until the plume attenuates to less than the 20,000 pCi/L DWS. For 2008, BNL will continue to monitor the g-2 source area wells on a quarterly basis. BNL will also continue to track the downgradient sections of the tritium plume using a combination of permanent and temporary wells.

The remaining areas of the AGS Complex will continue to be monitored on an annual basis.

5.27 Brookhaven Linac Isotope Producer Facility

In accordance with g-2/BLIP/UST ROD requirements, BNL will continue to monitor groundwater quality downgradient of BLIP until the source is no longer a threat to groundwater quality. For 2008, BNL will continue to monitor the BLIP wells on a quarterly basis.

5.28 Relativistic Heavy Ion Collider Facility

For 2008, groundwater samples will continue to be collected on a semi-annual basis.

5.29 Brookhaven Medical Research Reactor Facility

Starting in 2007, BNL reduced the monitoring frequency for the BMRR wells to once every two years. The next set of samples will be collected in 2008.

5.30 Sewage Treatment Plant

No changes to the STP groundwater monitoring program are proposed for 2008.

5.31 Motor Pool Maintenance Area

No changes to the Motor Pool groundwater monitoring program are proposed for 2008.

5.32 On-Site Service Station

No changes to the Service Station groundwater monitoring program are proposed for 2008.

5.33 Major Petroleum Facility Area

No changes to the Service Station groundwater monitoring program are proposed for 2008.

5.34 Waste Management Facility

During 2008, groundwater monitoring at the WMF will be conducted in accordance with the RCRA Part B Permit. The five new downgradient groundwater monitoring wells installed at the WMF in late 2007 will be incorporated into the monitoring program starting in February 2008.

5.35 Building 801

The monitoring frequency for well 065-325 for 2008 will continue to be semi-annual, and the monitoring will be conducted as close as possible with planned semi-annual sampling of wells 065-

37, 065-169, and 065-170 by the LTRA Program.

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