7

Groundwater Protection

Brookhaven National Laboratory's Groundwater Protection Management Program is made up of four elements: prevention, monitoring, restoration, and communication. The Laboratory has implemented aggressive pollution prevention measures to protect groundwater resources. An extensive groundwater monitoring well network is used to verify that prevention and restoration activities are effective. In 2006, BNL collected groundwater samples from 852 monitoring wells during 2,337 individual sampling events. Eleven groundwater remediation systems removed 372 pounds of volatile organic compounds and returned approximately 1.5 billion gallons of treated water to the Upper Glacial aquifer. Since the beginning of active groundwater remediation in December 1996, the Laboratory has removed 5,592 pounds of volatile organic compounds by treating nearly 11.6 billion gallons of groundwater. During 2006, two additional groundwater treatment systems removed approximately 5.3 millicuries of strontium-90 while remediating approximately 14 million gallons of groundwater. Since 2003, BNL has removed approximately 11.6 millicuries of strontium-90 while remediating 24.5 million gallons of groundwater.

7.1 THE BNL GROUNDWATER PROTECTION MANAGEMENT PROGRAM

The primary goal of BNL's Groundwater Protection Management Program is to ensure that plans for groundwater protection, management, monitoring, and restoration are fully defined, integrated, and managed in a manner that is consistent with federal, state, and local regulations. The program helps to fulfill the environmental monitoring requirements outlined in DOE Order 450.1, Environmental Protection Program, and is described in the BNL Groundwater Protection Management Program Description (Paquette et al. 2002). The program consists of four interconnecting elements: 1) preventing pollution of the groundwater, 2) monitoring the effectiveness of engineered and administrative controls at operating facilities and groundwater treatment systems, 3) restoring the environment by cleaning up contaminated soil and groundwater, and 4) communicating with stakeholders on groundwater protection issues. The Laboratory is committed to protecting groundwater resources from further chemical and radionuclide releases, and to remediating existing contaminated groundwater.

7.1.1 Prevention

As part of BNL's Environmental Management System, the Laboratory has implemented a number of pollution prevention activities that are designed to protect groundwater resources (see Chapter 2). BNL has established a work control program that requires the assessment of all experiments and industrial operations to determine their potential impact on the environment. The program enables the Laboratory to integrate pollution prevention and waste minimization, resource conservation, and compliance into planning and decision making. Efforts have been implemented to achieve or maintain compliance with regulatory requirements and to implement best management practices designed to protect groundwater (see Chapter 3). Examples include upgrading underground storage tanks, closing cesspools, and adding engineered controls (e.g., barriers to prevent rainwater infiltration that could move contaminants out of the soil and into groundwater) and administrative controls (e.g., reducing the toxicity and volume of chemicals in use or storage). Samples from groundwater monitoring wells are used to confirm that these controls are working.

7.1.2 Monitoring

The Laboratory's groundwater monitoring network is designed to evaluate the impacts of groundwater contamination from former and current operations and to track cleanup progress (see Table 7-1). Results from groundwater monitoring are used to verify that protection and restoration efforts are working. Groundwater monitoring is focused on two general areas: 1) Environmental Surveillance (ES) monitoring, designed to satisfy DOE and New York State monitoring requirements for active research and support facilities, and 2) Environmental Restoration (ER) monitoring related to BNL's obligations under the Comprehensive Environmental Response, Compensation and Liability Act. This monitoring is coordinated to ensure completeness and to prevent duplication of effort in the installation, monitoring, and abandonment of wells. The monitoring program elements have been integrated and include data quality objectives; plans and procedures; sampling and analysis; quality assurance; data management; and the installation, maintenance, and abandonment of wells. These elements were integrated to create a cost-effective monitoring system and to ensure that water quality data are available for review and interpretation in a timely manner.

Table 7-1. Summary of BNL Groundwater Monitoring Program, 2006.

	Environmental Restoration Program	Environmental Surveillance Program
Number of wells monitored	727	125
Number of sampling events	2,097	240
Number of analyses performed	4,381	656
Number of results	81,382	6,001
Percent of nondetectable analyses	92	92
Number of new wells installed (a)	4	0
Number of wells abandoned	0	0

Notes:
(a) Permanent wells only. Single-use temporary wells used for characterization are not included.

7.1.3 Restoration

BNL was added to the National Priorities List in 1989 (see Chapter 2 for a discussion of BNL's ER Program). To help manage the restoration effort, 30 separate Areas of Concern were grouped into six Operable Units (OUs). Remedial Investigation/Feasibility Studies have been conducted for each OU, and the focus is on installing and operating cleanup systems. Contaminant sources (e.g., contaminated soil and underground storage tanks) are being removed or remediated to prevent further contamination of groundwater. All remediation work is carried out under an Interagency Agreement involving EPA, the New York State Department of Environmental Conservation (NYSDEC), and DOE.

7.1.4 Communication

BNL's Community Education, Government and Public Affairs Program ensures that BNL communicates with its stakeholders in a consistent, timely, and accurate manner. A number of communication mechanisms are in place, such as press releases, web pages, mailings, public meetings, briefings, and roundtable discussions. Specific examples include routine meetings with the Community Advisory Council and the Brookhaven Executive Roundtable (see Chapter 2, Section 2.4.2). Quarterly and annual technical reports that summarize data, evaluations, and program indices are prepared. In addition, the Laboratory has developed a Groundwater Protection Contingency Plan (BNL 2003) that provides a formal process to communicate off-normal or unusual monitoring results to BNL's management, DOE, regulatory agencies, and other stakeholders, including the public and employees, in a timely manner.

7.2 GROUNDWATER PROTECTION PERFORMANCE

Under the BNL Groundwater Protection Management Program, the Laboratory began tracking progress in 1998 toward preventing new contamination of the aquifer system. BNL has made significant investments in environmental and groundwater protection, and is making progress in achieving its goal of preventing new groundwater impacts. A new groundwater impact is defined as the detection and confirmation of unusual or off-normal groundwater monitoring results. The Groundwater Protection Contingency Plan (BNL 2003), mentioned earlier as a communications too, also is designed to ensure that appropriate and timely actions are taken if unusual or off-normal results are observed. The contingency plan provides guidelines for evaluating the source of the problem, notifying stakeholders, and implementing appropriate corrective actions.

Since 1998, BNL has installed several hundred permanent and temporary monitoring wells following a comprehensive evaluation of known or potential contaminant source areas. Using this enhanced monitoring system, BNL identified 10 new groundwater impacts during 1998 through 2001 (see Figure 7-1). No additional impacts have been identified since 2001. Five of the 10 identified impacts were determined to be from historical (or "legacy") contaminant releases, and five were related to active science operations and environmental protection activities. In all 10 cases, BNL thoroughly investigated the cause of the contamination and took corrective actions as necessary to eliminate or limit the scale of the impacts. The Laboratory will continue efforts to prevent new groundwater impacts, and is vigilant in measuring and communicating its performance.

7.3 GROUNDWATER MONITORING

Elements of the groundwater monitoring program include installing monitoring wells; planning and scheduling; developing and following quality assurance procedures; collecting and analyzing samples; verifying, validating, and interpreting data; and reporting. Monitoring wells (which are not used for the drinking water supply) are used to evaluate BNL's progress in restoring groundwater quality, to comply with regulatory permit requirements, to monitor active research and support facilities, and to assess the quality of groundwater entering and leaving the site.

The Laboratory monitors research and support facilities where there is a potential for environmental impact, as well as areas where past waste handling practices or accidental spills have already degraded groundwater quality. The groundwater beneath the site is classified by New York State as Class GA groundwater, which is defined as a source of potable water supply. Federal drinking water

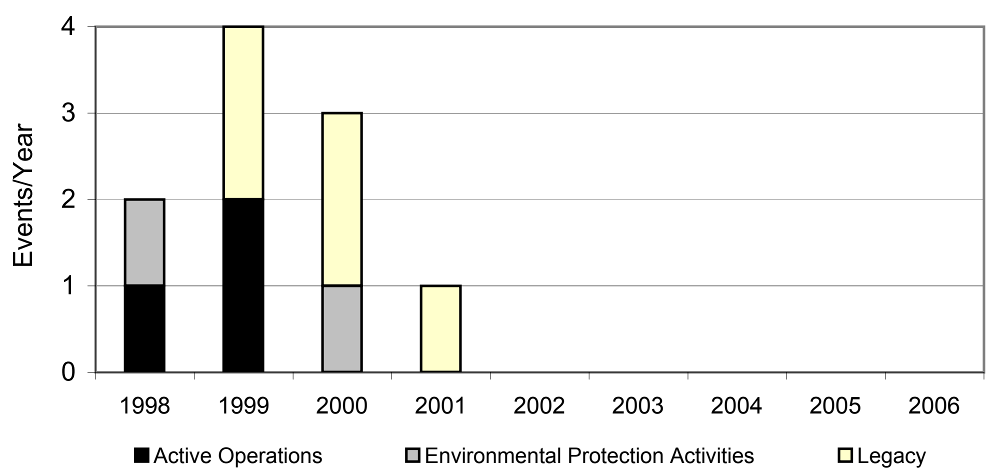


Figure 7-1. Groundwater Protection Performance, 1998 – 2006.

standards (DWS), New York State DWS, and New York State Ambient Water Quality Standards (NYS AWQS) for Class GA groundwater are used as goals for groundwater protection and remediation. BNL evaluates the potential impact of radiological and nonradiological contamination by comparing analytical results to the standards. Contaminant concentrations that are below the standards are also compared to background values to evaluate the potential effects from facility operations. The detection of low concentrations of facility-specific volatile organic compounds (VOCs) or radionuclides may provide important early indications of a contaminant release and allow for timely identification and remediation of the source.

Groundwater quality at BNL is routinely monitored through a network of approximately 860 on- and off-site wells (see SER Volume II, Groundwater Status Report, for details). In addition to water quality assessments, water levels are routinely measured in more than 875 on- and off-site wells to assess variations in the direction and velocity of flow. Groundwater flow directions in the vicinity of the Laboratory are shown in Figure 7-2.

The following active facilities have groundwater monitoring programs: the Sewage Treatment Plant area, Waste Management Facility, Central Steam Facility and adjacent Major Petroleum Facility, Alternating Gradient Synchrotron, Relativistic Heavy Ion Collider, Waste Concentration Facility, and several vehicle maintenance and petroleum storage facilities. Inactive facilities include the former Hazardous Waste Management Facility, two former landfill areas, the Brookhaven Graphite Research Reactor (BGRR), High Flux Beam Reactor (HFBR), and the Brookhaven Medical Research Reactor (BMRR). As a result of detailed groundwater investigations conducted over the past 15 years, six significant VOC plumes and eight radionuclide plumes have been identified (see Figures 7-3 and 7-4).

7.4 SUPPLEMENTAL MONITORING OF WATER SUPPLY WELLS

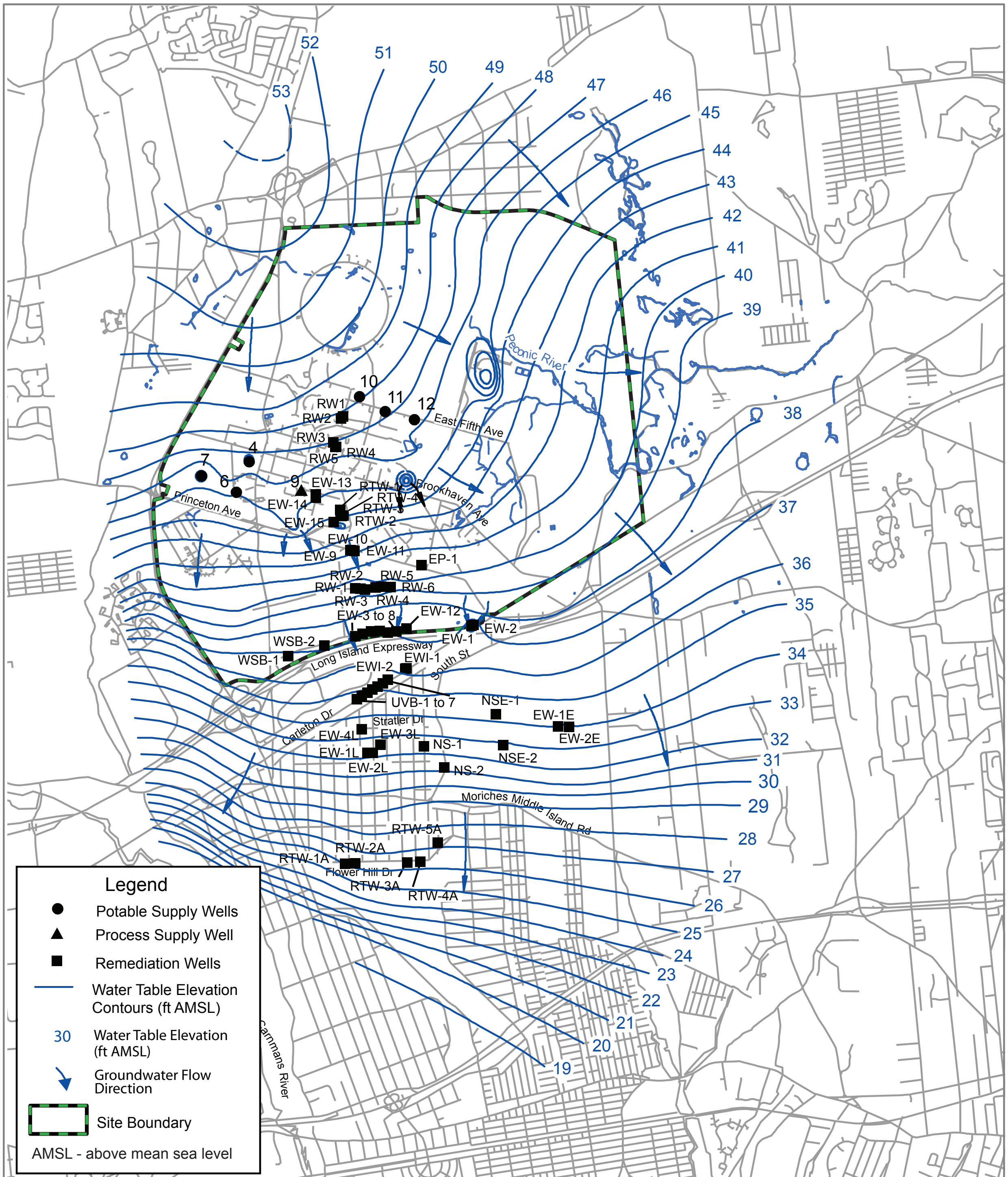
As discussed in Chapter 3, BNL is classified as a public water purveyor and maintains water supply wells and associated treatment facilities for the distribution of potable water on site. This water is also used for cooling water purposes at a number of facilities. Most of BNL's water supply is obtained from a network of six large-capacity wells (wells 4, 6, 7, 10, 11, and 12). A seventh well, number 9, is a small-capacity well that supplies process water to a facility where biological research is conducted. This well is not routinely monitored. The locations of the supply wells are shown in -2.

The quality of the BNL potable water supply is monitored as required by the Safe Drinking Water Act (SDWA), and the analytical results are reported to the Suffolk County Department of Health Services. As required by SDWA, the Laboratory also prepares an annual Water Quality Consumer Confidence Report (BNL 2006) that is distributed to all employees and guests. Results of the SDWA-required monitoring are described in Chapter 3.

All of BNL's supply wells are screened within the Upper Glacial aquifer. Because of the proximity of the potable supply wells to known or suspected groundwater contamination plumes and source areas, the Laboratory conducts a supplemental potable supply well monitoring program that includes testing for VOCs, anions, metals, and radiological parameters. During 2006, the BNL potable water system fully complied with all drinking water requirements. To better understand the geographical source of the Laboratory's drinking water and to identify potential sources of contamination within these geographical areas, BNL prepared the Source Water Assessment for Drinking Water Supply Wells (Bennett et al. 2000). In 2003, the New York State Department of Health (NYSDOH) prepared a source water assessment for all potable water supply wells on Long Island (NYSDOH 2003). The source water assessments are designed to serve as management tools in further protecting Long Island's sole source aquifer system.

7.4.1 Radiological Results

During 2006, samples collected from six supply wells were analyzed for gross alpha and gross beta activity, tritium, and strontium-90



Meters
0 750 1,500
0 2,500 5,000
Feet

Figure 7-2. Groundwater Flow and Water Table Elevation (December 2006) with Supply and Remediation Wells Shown.

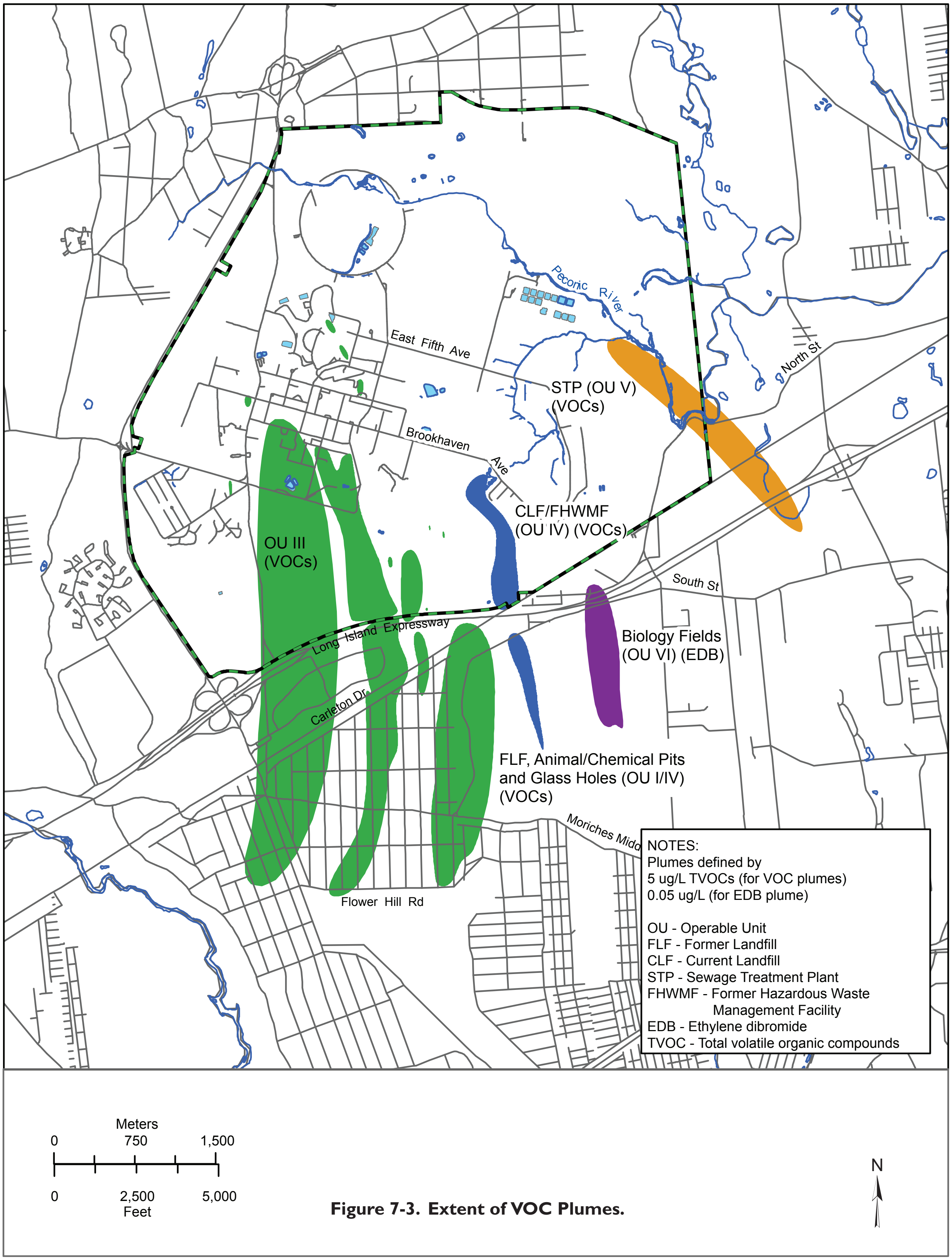


Figure 7-3. Extent of VOC Plumes.

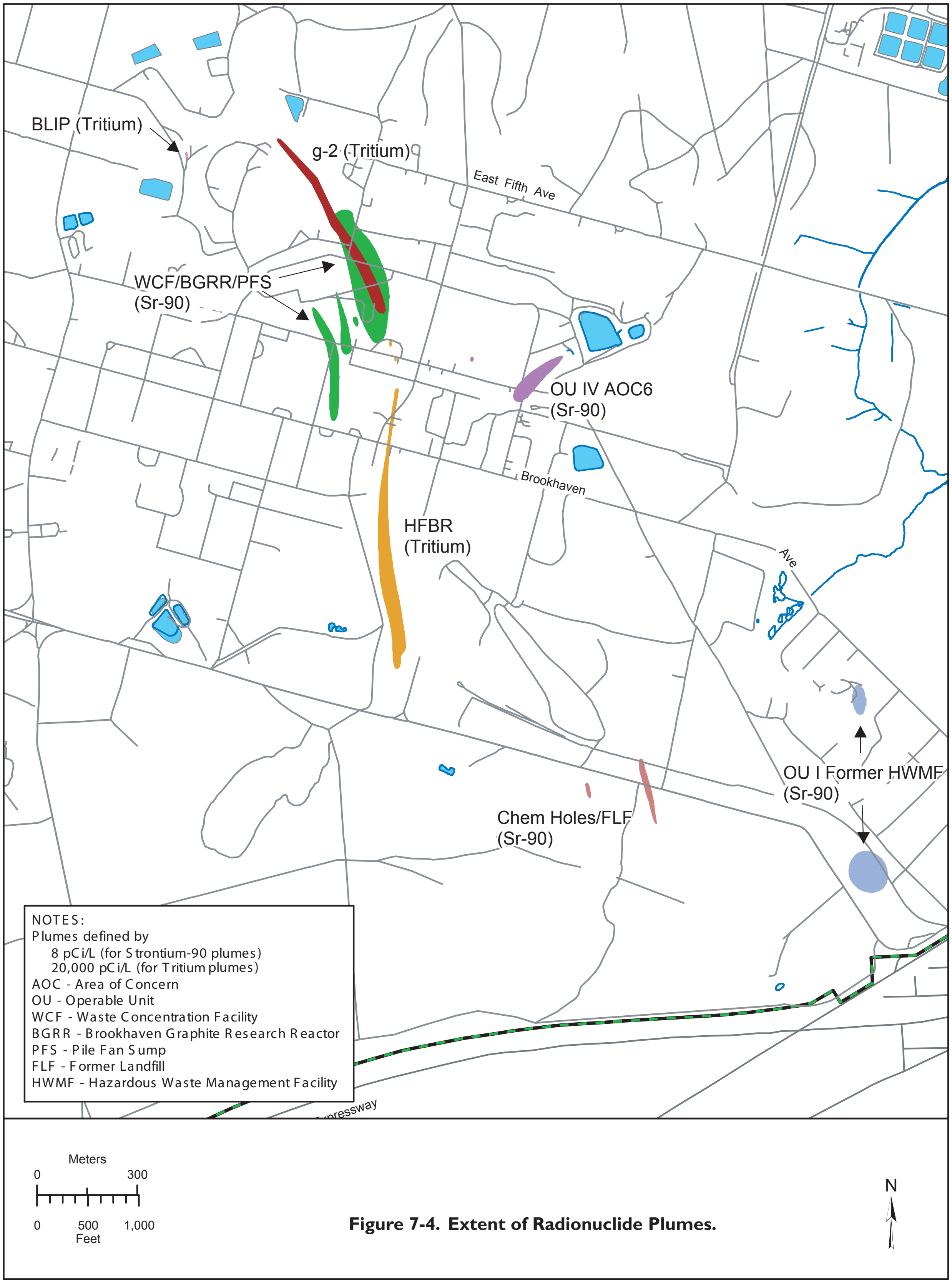


Figure 7-4. Extent of Radionuclide Plumes.

Table 7-2. Potable Well Radiological Analytical Results.

Potable Well ID		Gross Alpha	Gross Beta	Tritium	Sr-90
Well 4	Samples	1	1	1	1
	Max.	< 1.07	1.69 + 0.44	< 547	< 0.41
	Avg.	N/A	N/A	N/A	N/A
Well 6	Samples	4	4	4	4
	Max.	<1.2	< 2.65	< 653	< 0.69
	Avg.	0.45 ± 0.31	1.24 ± 0.37	-30.5 ± 220.14	-0.11± 0.37
Well 7	Samples	4	4	±	4
	Max.	< 1.7	< 2.54	< 553	< 0.69
	Avg.	0.61 ± 0.63	1.42 ± 0.54	29.65 ± 29.94	-0.4 ± 0.09
Well 10	Samples	1	1	1	1
	Max.	< 0.88	< 0.64	< 544	< 0.34
	Avg.	N/A	N/A	N/A	N/A
Well 11	Samples	2	2	2	2
	Max.	< 1.94	< 3.33	< 549	< 0.68
	Avg.	-0.21 ± 0.63	0.65 ± 0.74	209 ± 78.4	0.03 ± 0.11
Well 12	Samples	3	3	3	3
	Max.	< 1.7	< 2.69	< 554	< 0.76
	Avg.	-0.3 ± 0.5	0.99 ± 0.14	168.7 ± 149.3	-0.6 ± 0.26
SDWA Limit (pCi/L)		15 (a)	4 mrem (b)	20,000	8

Notes:
See Figure 7-2 for well locations.
All values presented with a 95% confidence interval.
Potable Well #10 was shut down most of the year due to its possible effect on groundwater flow direction in the vicinity of the g-2 Tritium Plume.
WS = Well shut down due to operational problems
(a) Excluding radon and uranium.
(b) The drinking water standards were changed from 50 pCi/L (concentration based) to (dose based) in late 2003. Because gross beta activity does not identify specific radionuclides, a dose equivalent cannot be calculated for the values in the table.

(Sr-90) (see Table 7-2). Nuclide-specific gamma spectroscopy was also performed for potable well samples. All radioactivity levels in the potable water wells were consistent with those of typical background water samples.

7.4.2 Nonradiological Results

In addition to the quarterly SDWA compliance samples described in Section 3.7 of Chapter 3, BNL collected supplemental VOC samples from active supply wells during the year. The samples were analyzed for VOCs following either EPA Standard Method 524 or 624. As in past years, low levels of chloroform continued to be routinely detected in samples from most wells, with a maximum concentration of 12.9 µg/L observed in 2006. The DWS for chloroform is 80 µg/L. Trace levels of several other VOCs (e.g., 1,1,1-trichloroethane [TCA], bromodichloromethane, and dibromochloromethane) were occasionally detected, but at concentrations well below applicable DWS. Samples were also analyzed for metals and anions one time during the year from wells 6, 7, 11, and 12 (see Tables 7-3 and 7-4). As in previous years, iron was the only parameter detected at concentrations greater than the DWS, which is 0.3 mg/L. The iron levels in wells 6 and 7 were 2.8 mg/L and 2.2 mg/L, respectively. Because high levels of iron are naturally present in some portions of the Upper Glacial aquifer on the western side of the Laboratory site, water obtained from wells 4, 6, and 7 is treated at the BNL Water Treatment Plant to reduce iron levels before it is distributed.

7.5 ENVIRONMENTAL SURVEILLANCE PROGRAM

BNL's Environmental Surveillance Program includes groundwater monitoring at 10 active research facilities (e.g., accelerator beam stop and target areas) and support facilities (e.g., fuel storage facilities). During 2006, 125 groundwater wells were monitored during 240 individual sampling events. Detailed descriptions and maps related to the ES groundwater monitoring program can be found in SER Volume II, Groundwater Status Report.

Although no new impacts to groundwater quality were discovered during 2006, groundwater quality continues to be impacted at four facilities: continued high levels of tritium at the g-2/VQ-12 area of the Alternating Gradient Synchrotron (AGS) facility; tritium at the Brookhaven Linac Isotope Producer (BLIP) facility; low levels of VOCs at the Motor Pool/Facility Maintenance area; and low levels of VOCs at the Service Station. Monitoring results for these areas are described below.

- Although tritium continues to be detected at concentrations above the 20,000 pico-curies per liter (pCi/L) DWS in wells immediately downgradient of the g-2/VQ-12 source area in the AGS facility, the levels are much lower than those observed in 2002 and 2003. Tritium concentrations reached a maximum of 3,440,000 pCi/L in 2002 and have shown a steady decline, remaining less than 100,000 pCi/L since July 2005. Tritium concentrations in the source area wells dropped to less than 45,000 pCi/L by the end of 2006.

- In January 2006, tritium concentrations exceeded the 20,000 pCi/L DWS in one well immediately downgradient of BLIP, with a concentration of 31,400 pCi/L. Tritium concentrations declined to less than the DWS limit for the remainder of the year.
- At the Motor Pool/Site Maintenance area, the solvents TCA and 1,1-dichloroethane (DCA) continued to be detected at concentrations greater than the NYS AWQS of 5 µg/L. TCA was detected at concentrations up to 18 µg/L, and DCA was detected at concentrations up to 6.6 µg/L. Methyl tertiary butyl ether (MTBE), a gasoline additive, was also detected, with a maximum observed concentration of 1.8 µg/L. The NYS AWQS for MTBE is 10 µg/L.
- At the Service Station, VOCs associated with petroleum products and solvents continued to be detected at concentrations greater than the NYS AWQS of 5 µg/L. Petroleum-related compounds detected in groundwater included m/p xylene at 480 µg/L, o-xylene at 210 µg/L, 1,2,4-trimethylbenzene at 360 µg/L, and 1,3,5-trimethylbenzene at 110 µg/L. The solvent tetrachloroethylene (TCE) was detected in several wells with a maximum concentration of 25 µg/L. Trace levels of MTBE were also detected, at a maximum concentration of 0.34 µg/L.

Although the engineered stormwater controls appeared to be effectively protecting the g-2/VQ-12 and BLIP source areas, monitoring data suggested that the continued release of tritium in both areas appeared to be caused by the flushing of residual tritium from the vadose (or unsaturated) zone following significant natural periodic rises in the local 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 half-life of tritium is 12.3 years).

Table 7-3. Potable Water Supply Wells Water Quality Data.

Potable Well ID		Chlorides	Sulfates	Nitrate and Nitrite
		mg/L		
Well 4	N	NS	NS	NS
	Value	–	–	–
Well 6	N	1	1	1
	Value	25.3	8.98	0.26
Well 7	N	1	1	1
	Value	23.6	10.1	0.29
Well 11	N	1	1	1
	Value	21.1	9.24	0.34
Well 12	N	1	1	1
	Value	23.2	10.9	0.55
NYS DWS		250	250	10
Typical MDL		4	4	1

Notes:
See Figure 7-2 for well locations.
Potable Well #10 was shut down most of the year due to its possible effect on groundwater flow direction in the vicinity of the g-2 Tritium Plume.
N = Number of samples
NYS DWS = New York State Drinking Water Standard
MDL = Minimum Detection Limit
NS = Well was not in operation during sample period

Monitoring of the leak detection systems at both vehicle maintenance facilities indicated that the gasoline storage tanks and associated distribution lines were not leaking. Furthermore, BNL's ongoing evaluation of 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 at these facilities originated from past vehicle maintenance activities, and are not related to current operations.

7.6 ENVIRONMENTAL RESTORATION GROUNDWATER MONITORING PROGRAM

The mission of the Laboratory's Environmental Restoration Groundwater Monitoring

Table 7-4. Total Metals Concentration Data for Potable Water Supply Well Samples.

Well ID		Ag	Al	As	Ba	Be	Cd	Co	Cr	Cu	Fe	Hg	Mn	Na	Ni	Pb	Sb	Se	Tl	V	Zn
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Well 4 *	N	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Value	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–			
Well 6 *	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Value	< 1.0	< 68	1.8	26.1	< 1.0	< 1.0	< 1.0	< 1.0	8.3	2.82	< 0.06	71.4	15	8.0	< 0.5	4.5	< 2.5	< 0.4	1.6	19.3
Well 7 *	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Value	< 1.0	< 68	2.1	22.5	< 1.0	< 1.0	< 1.0	< 1.0	3.6	2.25	< 0.06	82.8	16.4	2.3	0.59	< 4	< 2.5	< 0.4	< 1	28.7
Well 11	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Value	< 1.0	< 68	< 1.5	25.3	< 1.0	< 1.0	< 1.0	< 1.0	7.2	0.11	< 0.06	< 2	14.9	< 1	< 0.5	< 4	< 2.5	< 0.4	< 1	15.4
Well 12	N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Value	< 1.0	< 68	< 1.5	30	< 1.0	< 1.0	< 1.0	< 1.0	5.9	0.02	< 0.06	< 2	15.6	< 1	0.81	6.9	< 2.5	< 0.4	1.2	4.2
NYS DWS		100	SNS	50	2000	4	5	SNS	100	1300	0.3	2	300	SNS	SNS	15	6	50	2	SNS	5000
Typical MDL		1.0	68	1.5	1.0	1.0	1.0	1.0	1.0	3.0	0.08	0.1	2.0	1.0	1.1	0.5	4.0	2.5	0.4	1.0	2.0

Notes:
See Figure 7-2 for location of wells.
Potable Well #10 was shut down most of the year due to its possible effect on groundwater flow direction in the vicinity of the g-2 Tritium Plume.
* Water from these wells is treated at the Water Treatment Plant for color and iron reduction prior to site distribution.
MDL = Minimum Detection Limit
NYS DWS = New York State Drinking Water Standard
SNS = Drinking Water Standard not specified
NS = Well was not in operation during sample period

Program is to monitor the contaminant plumes on and off site. The monitoring results are used to track the progress that the groundwater treatment systems are making toward plume remediation. In 2006, a total of 727 groundwater wells were monitored, during 2,097 individual sampling events.

Maps showing the main VOC and radionuclide plumes are provided as Figures 7-3 and 7-4, respectively. Detailed descriptions and maps related to the ER Groundwater Monitoring Program can be found in SER Volume II, Groundwater Status Report. Highlights of the program are described below.

- The OU III Record of Decision (ROD) contingency of 20,000 pCi/L tritium at Weaver Drive was triggered with a detection of 21,000 pCi/L in a temporary well on November 2, 2006. A fourth extraction well (EW) will be installed to address the plume in the vicinity of Weaver Drive. It is anticipated that the new extraction well, along with EW-11 (and possibly EW-10), will be operational during the third quarter of 2007. A complete discussion of the triggering of the OU III ROD contingency and plans for the restart of the system are included in Volume II, Groundwater Status Report.
- Based on the results of monitoring well data collected since the last injection of potassium permanganate in the Building 96 source area in January 2006, it appears that additional remedial action will be required to reduce high VOC concentrations in the source area. An engineering study will be completed by the end of 2007 to evaluate remedial alternatives. Extraction well RTW-1 will be re-started to maintain hydraulic control of the source area.
- Additional characterization of the downgradient portion of the Chemical/Animal Holes Sr-90 plume was conducted in 2006. Two additional extraction wells will be needed to achieve the cleanup goal of meeting MCLs in the Upper Glacial aquifer by 2040. These wells will be operational by the end of 2007.
- Elevated levels of VOCs were observed in Airport perimeter well 800-96, which is outside the capture zone of the treatment system. Groundwater characterization was performed to determine the location of the plume in this area, and an additional extraction well will be installed to allow for complete capture of the plume. The new extraction well will be operational during the third quarter of 2007.
- OU III South Boundary system extraction wells EW-6 and -7 will be placed in standby mode in October 2007, due to low VOC concentrations in these wells. EW-8 and EW-12, which are also part of this system, are currently in standby mode.
- Industrial Park system well UVB-4 will be placed in standby beginning in October 2007, based on the low VOC concentrations being observed in this well over the past year. Well UVB-1, which is also part of this system, is currently in standby mode.
- Pulse pumping of the Industrial Park system will be implemented in 2007, due to low VOC concentrations (all wells are less than the capture goal of 50 µg/L total VOCs [TVOCs]). LIPA system extraction wells EW-1L and -3L will be placed in standby mode, as both of these wells have shown TVOC concentrations well below the 50 µg/L capture goal throughout 2006. In addition, all of the monitoring wells in this area have concentrations less than 50 µg/L TVOC.

7.7 GROUNDWATER TREATMENT SYSTEMS

The primary mission of the Laboratory's Environmental Restoration Program is to operate and maintain treatment systems that remediate groundwater contamination and prevent additional contamination from migrating off site. Groundwater remediation activities are expected to continue until approximately 2030 to meet the cleanup objectives for the plumes. 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

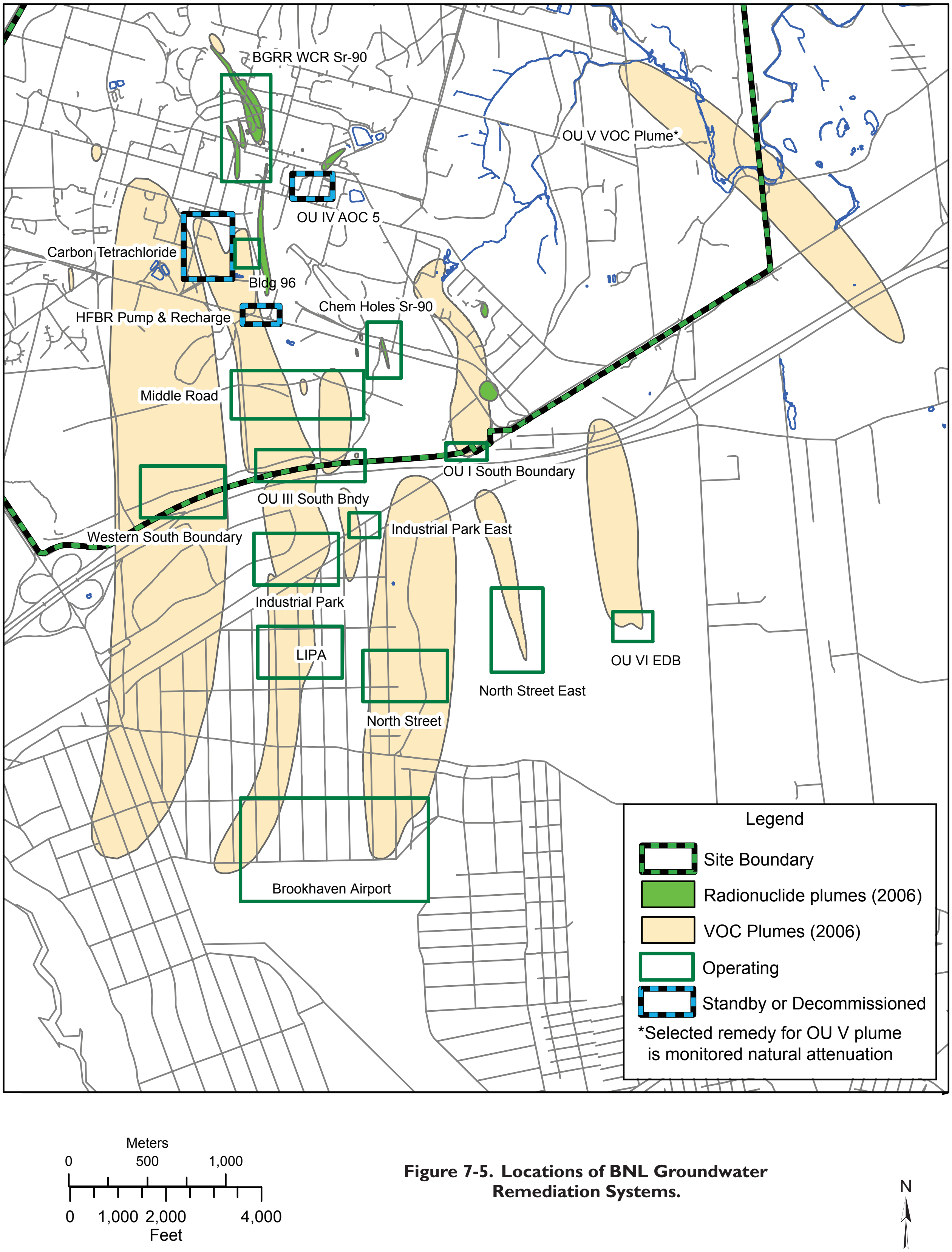


Figure 7-5. Locations of BNL Groundwater Remediation Systems.

Table 7-5. BNL Groundwater Remediation Systems Treatment Summary for 1997 through 2006.

		1997-2005		2006	
Remediation System	**Start Date**	**Water Treated** (Gallons)	**VOCs Removed** (Pounds) (e)	**Water Treated** (Gallons)	**VOCs Removed** (Pounds) (e)
OU I South Boundary	12/1996	2,893,249,000	323	154,065,000	8
OU III HFBR Tritium Plume (a)	05/1997	241,528,000	180	Not in Service	0
OU III Carbon Tetrachloride (d)	10/1999	153,538,075	349	Not in Service	0
OU III Building 96	02/2001	132,557,416	70	2,940,000	1
OU III Middle Road	10/2001	965,650,550	608	173,761,000	81
OU III South Boundary	06/1997	2,813,099,850	2,409	235,853,000	102
OU III Western South Boundary	09/2002	477,163,000	39	54,484,000	6
OU III Industrial Park	09/1999	1,083,298,330	901	151,180,000	66
OU III Industrial Park East	05/2004	143,598,000	24	82,574,000	5
OU III North Street	06/2004	345,841,000	187	157,281,000	45
OU III North Street East	06/2004	247,786,000	11	111,076,000	5
OU III LIPA/Airport	06/2004	437,682,000	145	238,205,000	53
OU IV AS/SVE (b)	11/1997	(c)	35	Decommissioned	0
OU VI EDB	08/2004	178,142,000	(f)	156,059,000	(f)
Total		**10,113,133,221**	**5,220**	**1,517,478,000**	**372**

		2003–2005		2006	
Remediation System	**Start Date**	**Water Treated** (Gallons)	**Sr-90 Removed** (mCi)	**Water Treated** (Gallons)	**Sr-90 Removed** (mCi)
OU III Chemical Holes Sr-90	02/2003	6,612,826	2.08	3,392,000	0.24
OU III BGRR/WCF Sr-90	06/2005	3,576,000	4.15	10,975,000	5.1
Total		**10,188,826**	**6.23**	**14,367,000**	**5.34**

Notes:
(a) System was shut down and placed in standby mode on September 29, 2000.
(b) System was shut down on January 10, 2001 and decommissioned in 2003.
(c) Air Sparging/Soil Vapor Extraction (AS/SVE) system performance is measured by pounds of VOCs removed per cubic feet of air treated.
(d) System was shut down and placed in standby mode in August 2004.
(e) Values are rounded to the nearest whole number.
(f) Because EDB has only been detected perodically at trace levels in the treatment systems influent, no removal of VOCs is reported.

- Achieve MCLs for Sr-90 at the BGRR in the Upper Glacial aquifer by 2070
- Achieve MCLs 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 previously described comprehensive groundwater monitoring program is used to measure the remediation progress.

In 2006, BNL continued to make significant progress in restoring groundwater quality on site, with 13 groundwater remediation systems in active operation. Figure 7-5 shows the locations of the groundwater treatment systems. Table 7-5 provides a summary of pounds of VOCs and curies of radioactivity removed, and gallons of water treated during 1997–2005. During 2006, 372 pounds of VOCs and 5.3 mCi of Sr-90 were removed from the groundwater, and more than 1.5 billion gallons of treated groundwater were returned to the aquifer. To date, 5,592 pounds of VOCs have been removed from the aquifer. Since the start of the first groundwater treatment system in 1996, noticeable improvements in groundwater quality are already evident in the OU I South Boundary, OU III South Boundary, OU III Industrial Park, OU III Industrial Park East, OU III North Street, OU IV, Building 96, and Carbon Tetrachloride areas. The Chemical Holes Strontium-90 System has removed 2.3 mCi of Sr-90 out of a projected 19.6 mCi total. The BGRR/Waste Concentration Facility Strontium-90 System, which started operation in June 2005, has removed 9.3 mCi of Sr-90 out of a projected total of 63.8 mCi. Detailed information on the groundwater treatment systems can be found in SER Volume II, Groundwater Status Report.

REFERENCES AND BIBLIOGRAPHY

Bennett, D., D. Paquette, K. Klaus, and W. Dorsch. *2000. Brookhaven National Laboratory, Source Water Assessment for Drinking Water Supply Wells.* BNL-52608. Brookhaven National Laboratory, Upton, NY. December 27, 2000.

BNL 2003. *Groundwater Protection Contingency Plan.* Brookhaven National Laboratory, Upton, NY. Standards Based Management System Subject Area. September 2003.

BNL 2006. *2006 BNL Water Quality Consumer Confidence Report.* Brookhaven National Laboratory Bulletin – Bulletin Special Edition. Upton, NY. May 31, 2006.

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

NYSDOH. 2003. *Long Island Source Water Assessment Summary Report.* New York Sate Department of Health June 23, 2003.

Paquette, D.E., D.B. Bennett, and W.R. Dorsch. *2002. Brookhaven National Laboratory, Groundwater Protection Management Program Description.* BNL Report 52664. Brookhaven National Laboratory, Upton, NY. May 31, 2002.