Water Quality 5

Wastewater generated from operations at Brookhaven National Laboratory is treated at the Sewage Treatment Plant (STP) before it is discharged to nearby groundwater recharge basins. Some wastewater may contain very low levels of radiological, organic, or inorganic contaminants. Monitoring, pollution prevention, and vigilant operation of treatment facilities ensure that these discharges comply with all applicable regulatory requirements and that the public, employees, and the environment are protected.

Analytical data for 2015 show that the average gross alpha and beta activity levels in the STP discharge (EA, Outfall 001) were within the typical range of historical levels and were well below New York State Drinking Water Standards (NYS DWS). Tritium was not detected above method detection limits in the STP discharge during the entire year and no cesium-137, strontium-90, or other gamma-emitting nuclides attributable to Laboratory operations were detected. Non-radiological monitoring of the STP effluent showed that organic and inorganic parameters were within State Pollutant Discharge Elimination System (SPDES) effluent limitations or other applicable standards.

The average concentrations of gross alpha and beta activity in stormwater and cooling water discharged to recharge basins were within typical ranges and no gamma-emitting radionuclides were detected. Tritium was detected in a single sample collected at Basin HO at a very low level (375 ± 229 pCi/L). Disinfection byproducts continue to be detected at very low concentrations, just above the method detection limit, in discharges to recharge basins due to the use of chlorine and bromine for the control of algae and bacteria in potable and cooling water systems. Inorganics (i.e., metals) were detected; however, their presence is due primarily to sediment runoff in stormwater discharges.

Radiological data from Peconic River surface water sampling show that the average concentrations of gross alpha and gross beta activity from on-site locations were indistinguishable from off-site locations and control locations, and all detected levels were below the applicable NYS DWS. No gamma-emitting radionuclides attributable to Laboratory operations were detected either upstream or downstream of the STP area, and tritium was not detected above method detection limits in any of the surface water samples. Samples collected upstream, downstream, and at control locations demonstrated that elevated amounts of aluminum and iron are associated with natural sources.

5.1 SURFACE WATER MONITORING PROGRAM

In addition to monitoring discharges under the SPDES program described in Chapter 3, BNL routinely monitors surface water quality (including radionuclides) as part of the site Surveillance Program. Although discharges of treated wastewater from the Laboratory's STP into the headwaters of the Peconic River ceased in October 2014, the Laboratory continues to monitor surface water at several locations along the Peconic River to assess the impact that site operations may have on surface water quality. On-site monitoring station HY is located upstream of all Laboratory operations, and provides information on the background water quality of the Peconic River (see Figure 5-4).

The Carmans River is monitored as a geographic control location for comparative purposes, as it is not affected by operations at BNL and is not within the Peconic River watershed.

On the Laboratory site, the Peconic River is an intermittent, groundwater fed stream. Off-site flow occurs only following periods of sustained precipitation and a concurrent rise in the water table, typically in the spring. Off-site flow in 2015 was only persistent between mid-March through the end of April due to a wet spring. When flow ceased, standing water was present throughout the year in several of the deeper sections of the river.

Five years of analytical data associated with BNL's surface water monitoring program were evaluated in 2012, and a determination was made to reduce the sampling frequencies for both on- and off-site Peconic River monitoring stations starting in 2013. This decision was based on the fact that historical monitoring data indicates no significant variations in water quality throughout the Peconic River system. Peconic River Remediation efforts have been completed, and pollution prevention efforts at the Laboratory have significantly reduced the risk of accidental releases. This decision is further supported by the October 2014 redirection of STP discharges away from the Peconic River. The following sections describe BNL's groundwater and surface water monitoring and surveillance programs.

5.2 SANITARY SYSTEM EFFLUENTS

The STP effluent (Outfall 001) is a discharge point authorized under BNL's SPDES permit that is issued by NYSDEC (Section 3.6.1). Figure 5-1 shows a schematic for discharge of treated STP effluent to nearby groundwater recharge basins. The Laboratory's STP treatment process includes three principal steps: 1) aerobic oxidation for secondary removal of biological matter and nitrification of ammonia, 2) secondary clarification, and 3) filtration for final solids removal. Tertiary treatment for nitrogen removal is also provided by controlling the oxygen levels in the aeration tanks. During the aeration process, the oxygen levels are allowed to drop to the point where microorganisms use nitrate-bound oxygen for respiration; this liberates nitrogen gas and consequently reduces the concentration of nitrogen in the STP discharge.

Real-time monitoring of the sanitary waste stream for radioactivity, pH, and conductivity occurs at two locations. The first site, MH-192, is approximately 1.1 miles upstream of the STP, and provides a minimum of 30 minutes' warning to the STP operators that wastewater is en-route that may exceed SPDES limits or BNL administrative effluent release criteria. The second monitoring site is at the point where the STP influent enters the treatment process.

Based on the data collected by the real-time monitoring systems, any influent to the STP that may not meet SPDES limits and BNL effluent release criteria can be diverted to two double-lined holding ponds. The total combined capacity of the two holding ponds exceeds 6 million gallons, or approximately 18 days of flow. Diversion would continue until the effluent's water quality meets the permit limits and release criteria. If wastewater is diverted to the holding ponds, it is tested and evaluated against the requirements for release. If necessary, the wastewater is treated and then reintroduced into the STP at a rate that ensures compliance with SPDES permit limits for non-radiological parameters or BNL effluent release criteria for radiological parameters. In 2015, there were no instances that required diversion of wastewater to the hold-up ponds.

Solids separated in the clarifier are pumped to aerobic digesters for continued biological solids reduction and sludge thickening. Once the sludge in the aerobic digester reaches a solids content of 6 percent, the sludge is sampled to ensure it meets the waste acceptance criteria for disposal at the Suffolk County Department of Public Works Sewage Treatment Facility at Bergen Point, in West Babylon, New York.

5.2.1 Sanitary System Effluent–Radiological Analyses

Wastewater at the STP is sampled at the inlet to the treatment process, Station DA, and at the STP outfall, Station EA, as shown on Figure 5-1. At each location, samples are collected on a flow-proportional basis; that is, for every 1,000 gallons

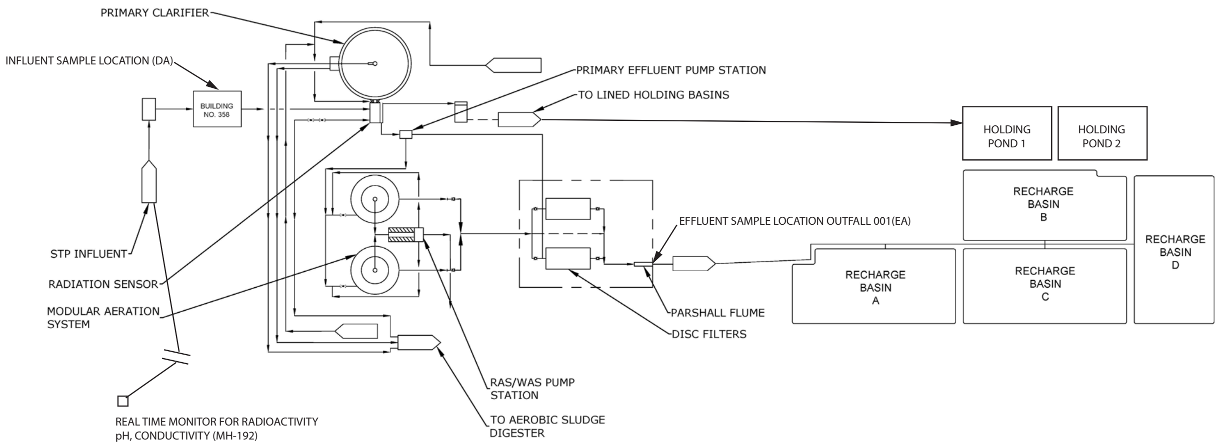

Figure 5-1. Schematic of BNL's Sewage Treatment Plant (Recharge Basin Discharge)

of water treated, approximately 4 fluid ounces of sample are collected and composited into a 5-gallon collection container. These samples are analyzed weekly for gross alpha and gross beta activity and for tritium. Samples collected from these locations are also composited and analyzed monthly for gamma-emitting radionuclides and strontium-90 (Sr-90: half-life, 29 years).

Although the STP discharge is not used as a direct source of potable water, the Laboratory applies the stringent Safe Drinking Water Act (SDWA) standards for comparison purposes when monitoring the effluent, in lieu of DOE wastewater criteria. Under the SDWA, water standards are based on a 4 mrem (40 µSv) dose limit. The SDWA specifies that no individual may receive an annual dose greater than 4 mrem from radionuclides that are beta or photon emitters, which includes up to 168 individual radioisotopes. BNL performs radionuclide-specific gamma analysis to ensure compliance with this standard. The SDWA annual average gross alpha activity limit is 15 pCi/L, including radium-226 (Ra-226: half-life, 1,600 years), but excluding radon and uranium. Other SDWA-specified drinking water limits are 20,000 pCi/L for tritium (H-3: half-life, 12.3 years), 8 pCi/L for Sr-90, 5 pCi/L for Ra-226 and radium-228 (Ra-228: half-life, 5.75 years), and 30 µg/L for uranium. Gross alpha and beta activity measurements are used as a screening tool for detecting the presence of radioactivity. Table 5-1 shows the monthly gross alpha and beta activity data and tritium concentrations for the STP influent and effluent during 2015. Annual average gross alpha and beta activity levels in the STP effluent were 0.2 ± 0.1 pCi/L and 3.8 ± 0.2 pCi/L, respectively. These concentrations have remained essentially unchanged from year to year and are consistent with concentrations detected in the Peconic River and at the control location off site (Carmans River). Tritium was not detected above method detection limits in the discharge of the STP (EA, Outfall 001) for the entire year. The annual average tritium concentration, as measured in the STP effluent, was 29.4 pCi/L, which is only 7 percent of the average minimum detection level (MDL) of 396 pCi/L, and well below the NYS DWS of 20,000 pCi/L. Using the annual average concentration and the flow recorded for the year, a total of 0.012 Ci (12 mCi) of tritium was released during 2015, which is consistent with annual total releases of tritium over the past 5 years. In 2015, there were no gamma-emitting nuclides detected in the STP effluent, which is consistent with data reported since 2003. Strontium-90 was detected in one effluent sample collected in October (0.19 ± 0.11 pCi/L); however, this value is consistent with historical levels and

Table 5-1. Tritium and Gross Activity in Water at the BNL Sewage Treatment Plant (STP).

		Flow (Liters)	Tritium (pCi/L)		Gross Alpha (pCi/L)		Gross Beta (pCi/L)	
			max.	avg.	max.	avg.	max.	avg.
January	*influent*	3.11E+07	< 428	< MDL	2.4 ± 1.4	1.1 ± 0.9	5.5 ± 0.8	4.3 ± 0.9
	effluent	2.48E+07	< 452	< MDL	< 1.7	0.6 ± 0.3	4.2 ± 0.8	3.9 ± 0.2
February	*influent*	2.96E+07	< 423	< MDL	2.0 ± 1.2	1.3 ± 0.6	5.6 ± 0.8	4.6 ± 1.3
	effluent	2.35E+07	< 426	< MDL	< 1.6	0.2 ± 0.4	4.4 ± 0.7	4.1 ± 0.5
March	*influent*	4.18E+07	< 393	< MDL	< 1.7	0.7 ± 0.5	5.8 ± 1.3	3.9 ± 1.3
	effluent	3.39E+07	< 395	< MDL	< 1.6	0.3 ± 0.6	4.5 ± 0.6	3.6 ± 0.8
April	*influent*	3.84E+07	< 365	< MDL	< 2.3	0.8 ± 0.6	3.9 ± 0.6	2.9 ± 0.7
	effluent	3.69E+07	< 430	< MDL	< 1.9	0.3 ± 0.6	3.5 ± 0.7	2.8 ± 0.8
May	*influent*	4.35E+07	< 337	< MDL	< 3.7	1.1 ± 0.8	4.7 ± 1.2	3.5 ± 1.0
	effluent	3.70E+07	< 388	< MDL	< 1.5	0.1 ± 0.5	3.6 ± 0.7	3.2 ± 0.4
June	*influent*	5.35E+07	< 386	< MDL	< 5.1	1.0 ± 0.2	4.5 ± 1.0	3.8 ± 0.6
	effluent	4.42E+07	< 378	< MDL	< 1.7	0.2 ± 0.4	6.1 ± 0.8	4.2 ± 1.1
July	*influent*	4.77E+07	< 386	< MDL	< 2.2	0.1 ± 0.4	5.5 ± 1.2	5.1 ± 0.3
	effluent	3.86E+07	< 378	< MDL	0.8 ± 0.5	0.3 ± 0.4	4.3 ± 0.8	3.8 ± 0.5
August	*influent*	6.74E+07	< 393	< MDL	< 4.0	0.9 ± 0.9	3.4 ± 0.6	2.8 ± 0.5
	effluent	5.08E+07	< 378	< MDL	< 1.1	0.0 ± 0.3	4.6 ± 1.2	4.0 ± 0.5
September	*influent*	4.36E+07	< 462	< MDL	< 5.9	0.8 ± 0.7	6.3 ± 2.0	4.2 ± 1.6
	effluent	3.36E+07	< 456	< MDL	< 1.8	0.3 ± 0.4	3.9 ± 0.7	3.3 ± 0.5
October	*influent*	4.08E+07	< 358	< MDL	2.7 ± 1.7	1.3 ± 1.2	4.1 ± 0.9	3.7 ± 0.7
	effluent	3.12E+07	< 353	< MDL	< 1.6	0.1 ± 0.3	4.9 ± 0.7	4.5 ± 0.3
November	*influent*	4.20E+07	< 307	< MDL	< 4.0	0.9 ± 0.8	5.9 ± 1.8	4.1 ± 1.3
	effluent	2.96E+07	< 339	< MDL	< 2.4	0.2 ± 0.3	6.1 ± 1.3	4.3 ± 1.1
December	*influent*	2.74E+07	< 399	< MDL	< 4.2	0.5 ± 0.4	3.8 ± 1.2	2.8 ± 1.2
	effluent	2.09E+07	< 470	< MDL	< 2.7	0.3 ± 0.5	5.6 ± 1.1	4.3 ± 1.2
Annual Avg.	*influent*			< MDL		0.9 ± 0.2		3.8 ± 0.3
	effluent			< MDL		0.2 ± 0.1		3.8 ± 0.2
Total Release		**4.05E+08**		**12.2 mCi**		**0.1 mCi**		**1.5 mCi**
Average MDL (pCi/L)				**396**		**2.0**		**0.9**
SDWA Limit (pCi/L)				**20,000**		**15**		**(a)**

Notes:
All values are reported with a 95% confidence interval.
To convert values from pCi to Bq, divide by 27.03.
MDL = minimum detection limit
SDWA = Safe Drinking Water Act
(a) The drinking water standards were changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in 2003. As gross beta activity does not identify specific radionuclides, a dose equivalent cannot be calculated for the values in the table.

most likely attributable to worldwide fallout and not BNL-derived.

5.2.2 Sanitary System Effluent – Nonradiological Analyses

Starting in 2013, monitoring of the STP effluent for volatile organic compounds (VOCs), inorganics, and anions as part of the Surveillance Program was discontinued. These parameters are now only monitored as part of the SPDES Compliance Program, which is discussed in further detail in Chapter 3.

5.3 PROCESS-SPECIFIC WASTEWATER

Wastewater that may contain constituents above SPDES permit limits or ambient water quality discharge standards must be held by the generating facility and characterized to determine the appropriate means of disposal. The analytical results are compared with the appropriate discharge limit, and the wastewater is released to the sanitary system if the volume and concentration of contaminants in the discharge would not jeopardize the quality of the STP effluent and, subsequently, potentially impact groundwater quality (BNL 2014).

The Laboratory's SPDES permit includes requirements for quarterly sampling and analysis of process-specific wastewater discharged from metal cleaning operations in Building 498 and cooling tower discharges from Building 902. Although still listed as a discharge monitoring location, discharges from the printed-circuit-board fabrication operations that had been conducted in Building 535B have been discontinued. These operations are monitored for contaminants such as metals, cyanide, VOCs, and semi-volatile organic compounds (SVOCs). In 2015, analyses of these waste streams showed that, although several operations contributed contaminants (principally metals) to the STP influent in concentrations exceeding SPDES-permitted levels, these discharges did not affect the quality of the STP effluent.

Process wastewaters that were not expected to be of consistent quality, because they were not routinely generated, were held for characterization before release to the sanitary system. The process wastewaters typically included purge water from groundwater sampling, wastewater from cleaning of heat exchangers, wastewater generated as a result of restoration activities, and other industrial wastewaters. To determine the appropriate disposal method, samples were analyzed for contaminants specific to the process. The analyses were then reviewed and the concentrations were compared to the SPDES effluent limits and BNL's effluent release criteria (BNL 2014). If the concentrations were within limits, authorization for sewer system discharge was granted; if not, alternate means of disposal were used. Any waste that contained elevated levels of hazardous or radiological contaminants in concentrations that exceeded Laboratory effluent release criteria was sent to the BNL Waste Management Facility for proper management and off-site disposal.

5.4 RECHARGE BASINS

Recharge basins are used for the discharge of "clean" wastewater, including once-through cooling water, stormwater runoff, and cooling tower blowdown. These wastewaters are suitable for direct replenishment of the groundwater aquifer. Figure 5-2 shows the locations of the Laboratory's discharges to recharge basins (also called "outfalls" under BNL's SPDES permit). Figure 5-3 presents an overall schematic of potable water use at the Laboratory, and how much of this water is discharged to the 11 on-site recharge basins:

- Basins HN, HT-W, and HT-E receive once-through cooling water discharges generated at the Alternating Gradient Synchrotron (AGS) and Relativistic Heavy Ion Collider (RHIC), as well as cooling tower blowdown and stormwater runoff.
- Basin HS receives predominantly stormwater runoff, once-through cooling water from Building 555 (Chemistry Department) and minimal cooling tower blowdown from the National Synchrotron Light Source (NSLS).
- Basin HX receives Water Treatment Plant filter backwash water.
- Basin HO receives cooling water discharges from the AGS and stormwater runoff from the area surrounding the High Flux Beam Reactor (HFBR).
- Several other recharge areas are used exclusively for discharging stormwater runoff. These areas include Basin HW near the National Synchrotron Light Source II (NSLS-II) site, Basin CSF at the Central Steam Facility (CSF), Basin HW-M at the former Hazardous Waste Management Facility (FHWMF), and Basin HZ near Building 902. Recharge Basins HP and RAV are used for discharge of treated water from the groundwater remediation systems and are monitored under BNL's Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) equivalency permits.

Each of the recharge basins is a permitted point-source discharge under the Laboratory's SPDES permit. Where required by the permit, the basins are equipped with a flow monitoring station; allowing for weekly recordings of flow rates. The specifics of the SPDES compliance

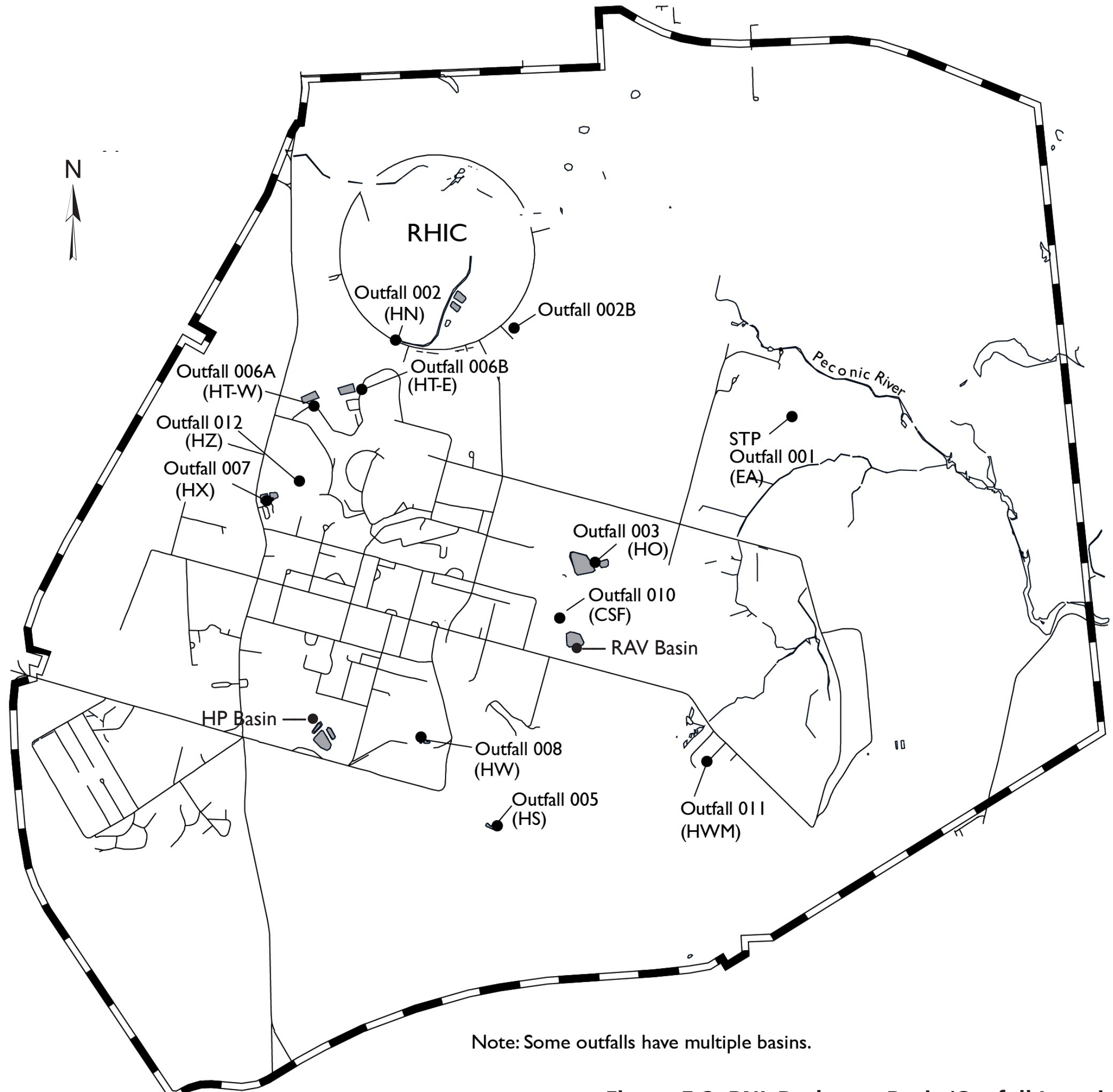

Figure 5-2. BNL Recharge Basin/Outfall Locations.

monitoring program are provided in Chapter 3. To supplement the monitoring program, samples are also routinely collected and analyzed under BNL's Environmental Surveillance Program for radioactivity, VOCs, metals, and anions. During 2015, water samples were collected from all the basins listed above semi-annually except for recharge Basin HX at the Water Treatment Plant due to previously documented non-impact to groundwater from plant operations, and the recharge basin at the FHWMF, as there are no longer any operations that could lead to the contamination of runoff.

5.4.1 Recharge Basins – Radiological Analyses

Discharges to the recharge basins were sampled semi-annually and analyzed for gross alpha and beta activity, gamma-emitting radionuclides, and tritium. The results are presented in Table 5-2. Gross alpha activity was not detected at any of the recharge basins discharges and gross beta activity ranged from non-detectable to 27.4 ± 37.4 pCi/L. Low-level detections of beta activity are attributable to very low levels of naturally occurring radionuclides, such as potassium-40 (K-40: half-life, 1.3E+09 years).

No gamma-emitting nuclides attributable to

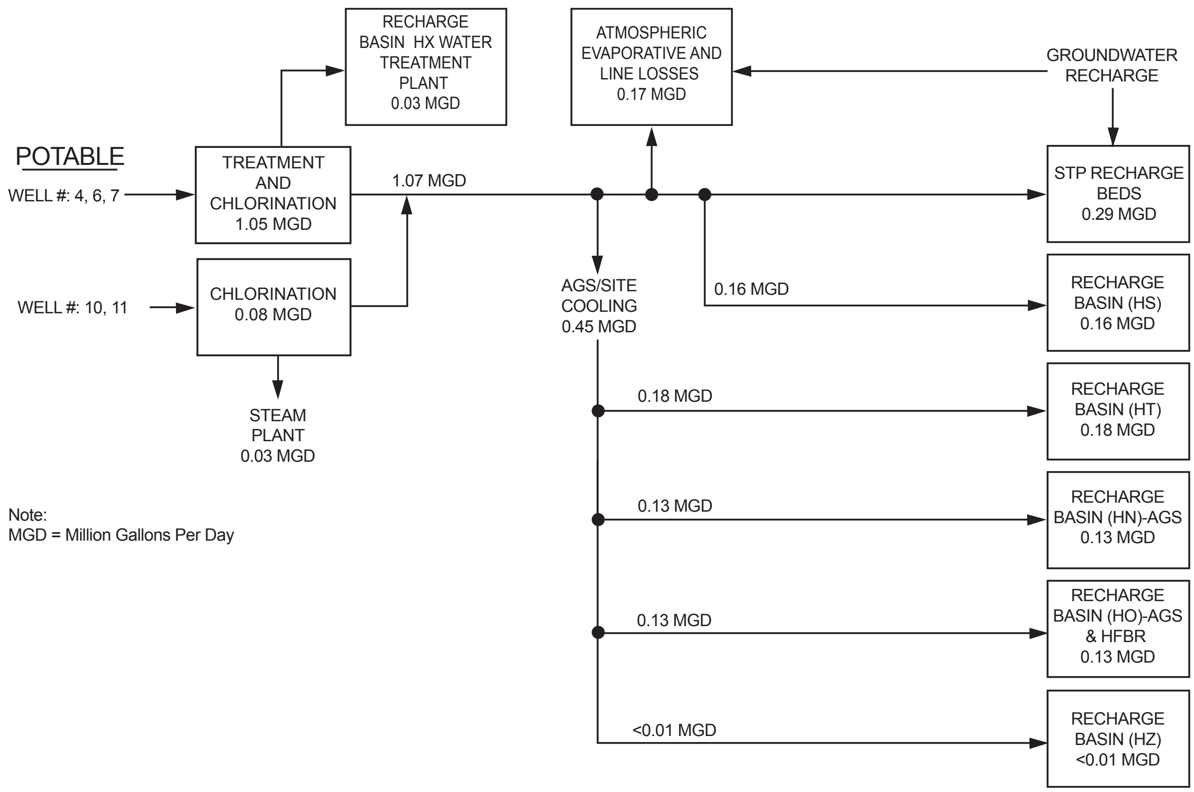

Figure 5-3. Schematic of Potable Water Use and Flow at BNL.

BNL operations were detected in any discharges to recharge basins in 2015. Tritium was detected in a single sample collected at Basin HO (375 ± 229 pCi/L); however, due to the low level of detection and high uncertainty, the data may be false-positive.

5.4.2 Recharge Basins – Nonradiological Analyses

During 2015, discharge samples were collected semi-annually for water quality parameters, metals, and VOCs. Field-measured parameters (pH, conductivity, and temperature) were routinely monitored and recorded. The water quality and metals analytical results are summarized in Tables 5-3 and 5-4. To determine the overall impact on the environment from discharges to the recharge basins, the nonradiological analytical results were compared to groundwater discharge standards promulgated under Title 6 of the New York Codes, Rules, and Regulations (NYCRR), Part 703.6.

Low concentrations of disinfection byproducts were periodically detected above method detection limits in discharges to several of the basins throughout the year. Sodium hypochlorite and bromine, used to control bacteria in the drinking water and algae in cooling towers, lead to the formation of VOCs, including bromoform, chloroform, dibromochloromethane, and dichlorobromomethane. All concentrations were less than 3 µg/L. No other VOCs were detected above method detection limits in any of the discharges to the recharge basins.

The analytical data presented in Table 5-3 show that for 2015, the concentrations of all analytes were within effluent standards, except for high detections of chlorides in Basins HT-E, CSF, and HZ. Chlorides are found to be higher in samples collected during the winter and are attributed to road salt used to control snow and ice buildup. The samples with elevated chloride levels from Basins HT-E, CSF, and HZ were collected in February during a rain event and likely reflect the washing out of road salt

Table 5-2. Radiological Analysis of Samples from BNL On-Site Recharge Basins.

Basin		Gross Alpha	Gross Beta	Tritium
			(pCi/L)	
No. of samples		2	2	2
HN	*max.*	< 1.23	2.57 ± 0.96	< 388
	avg.	0.53 ± 0.08	1.63 ± 1.84	< MDL
HO	*max.*	< 1.96	1.12 ± 0.68	375 ± 229
	avg.	-0.44 ± 0.43	0.99 ± 0.25	< MDL
HS (b)	*max.*	< 3.79	< 2.17	< 378
	avg.	NA	NA	NA
HT-E	*max.*	< 1.19	27.4 ± 37.4	< 378
	avg.	-21.57 ± 42.98	14.19 ± 25.9	< MDL
HT-W	*max.*	< 1.15	1.15 ± 0.5	< 375
	avg.	0.59 ± 0.55	0.95 ± 0.39	< MDL
HW	*max.*	< 1.89	2.31 ± 0.54	< 441
	avg.	0.87 ± 1.03	1.88 ± 0.83	< MDL
HZ	*max.*	< 22 (c)	< 7.79	< 452
	avg.	10.02 ± 19.17	0.86 ± 0.57	< MDL
SDWA Limit		15	(a)	20,000

Notes:
See Figure 5-2 for recharge basin/outfall locations.
All values reported with a 95% confidence interval.
Negative numbers occur when the measured value is lower than background (see Appendix B for description).
To convert values from pCi to Bq, divide by 27.03.
(a) The drinking water standard was changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in 2003. As gross beta activity does not identify specific radionuclides, a dose equivalent of this value cannot be calculated.
(b) Only one sample was collected from Basin HS in 2015.
(c) Due to high solids content, the minimum detection limit for this sample was very high.
MDL = minimum detection limit
SDWA = Safe Drinking Water Act

applied during previous snow events. High concentrations of sodium detected in a sample from Basin HT-E confirmed road salt as the source of chlorides, as shown in Table 5-4. All other metals complied with the respective water quality or groundwater discharge standards. As described above, the elevated sodium was most likely caused by runoff from road salting activities during winter storms.

5.4.3 Stormwater Assessment

All recharge basins receive stormwater runoff. Stormwater at BNL is managed by collecting runoff from paved surfaces, roofs, and other impermeable surfaces and directing it to recharge basins via underground piping and above-grade vegetated swales. Recharge Basin HS receives most of the stormwater runoff from the central, developed portion of the Laboratory site. Basins HN, HZ, HT-W, and HT-E receive runoff from the Collider-Accelerator complex. Basin HO receives runoff from the area surrounding the HFBR. Basin CSF receives runoff from the CSF area and along Cornell Avenue east of Renaissance Road. Basin HW receives runoff from the NSLS-II site, and HW-M receives runoff from the fenced area at the FHWMF.

Stormwater runoff at the Laboratory typically has elevated levels of inorganics (i.e., metals) and has a low pH. The inorganics are attributable to high sediment content in stormwater (inorganics occur naturally in native soil). In an effort to further improve the quality of stormwater runoff on site, BNL has formal procedures for managing and maintaining outdoor work and storage areas. The requirements include covering of equipment and materials (e.g., road salt storage bins/containers with potential to leak residual oils or any other hazardous materials), to prevent contact with stormwater, conducting an aggressive maintenance and inspection program, implementing erosion control measures during soil disturbance activities, and restoring these areas when operations cease. Basin sediment sampling is conducted on a 5-year testing cycle to ensure these discharges are in compliance with regulatory requirements. The next sampling event will occur in 2017.

5.5 PECONIC RIVER SURVEILLANCE

Several locations are monitored along the Peconic River to assess the overall water quality of the river and to assess any impact from BNL operations. Sampling points along the Peconic River are identified in Figure 5-4. In total, ten stations (three upstream and seven downstream of the former STP discharge) were sampled in 2015. A sampling station along the Carmans River (HH) was also monitored as a geographic control location, not affected by Laboratory operations or located within the Peconic River watershed. The

Table 5-3. Water Quality Data for BNL On-Site Recharge Basin Samples.

ANALYTE		Recharge Basin HN (RHIC)	HO (AGS)	HS (s)	HT-W (Linac)	HT-E (AGS)	HW (s)	CSF (s)	HZ (s)	NYSDEC Effluent Standard	Typical MDL
No. of samples		2	2	1	2	2	2	2	2		
pH (SU)	*min.*	8.0	7.6	8.3	7.6	6.5	7.6	7.8	6.9	6.5 - 9.0	NA
	max.	8.0	7.6	8.3	7.7	7.8	7.9	8.2	7.6		
Conductivity (µS/cm)	*min.*	259	221	NA	214	279	46	128	247	SNS	NA
	max.	661	656	634	242	29543	419	2524	2136		
	avg.	460	439	NA	228	14911	233	1326	1192		
Temperature (ºC)	*min.*	6.0	10.1	NA	5.8	5.2	0.6	1.5	9.0	SNS	NA
	max.	23.4	19.6	27.9	25.6	26.2	22.2	23.5	21.8		
	avg.	14.7	14.9	NA	15.7	15.7	11.4	12.5	15.4		
Dissolved oxygen (mg/L)	*min.*	9.3	9.2	NA	9.0	8.7	8.1	8.3	8.9	SNS	NA
	max.	11.4	9.9	11.3	11.2	12.1	14.1	13.6	11.2		
	avg.	10.4	9.5	NA	10.1	10.4	11.1	10.9	10.1		
Chlorides (mg/L)	*min.*	53	45	NA	46	51	7	16	52	500	4
	max.	160	190	130	50	11000	210	770	1300		
	avg.	107	118	NA	48	5526	109	393	676		
Sulfates (mg/L)	*min.*	11.0	10.0	NA	9.4	11.0	1.5	4.2	11.0	500	4
	max.	16.0	11.0	19.0	9.9	50.0	1.9	6.3	15.0		
	avg.	13.5	10.5	NA	9.7	30.5	1.7	5.3	13.0		
Nitrate as nitrogen (mg/L)	*min.*	0.5	0.3	NA	0.3	0.3	0.1	0.2	0.2	10	1
	max.	0.6	0.3	1.5	0.3	0.4	0.3	0.4	0.4		
	avg.	0.5	0.3	NA	0.3	0.4	0.2	0.3	0.3		

Notes:
See Figure 5-2 for the locations of recharge basins/outfalls.
(s) = stormwater
AGS = Alternating Gradient Synchrotron
Linac = Linear Accelerator
MDL = Minimum Detection Limit
NA = Not Applicable
NYSDEC = New York State Department of Environmental Conservation
RHIC = Relativistic Heavy Ion Collider
SNS = Effluent Standard Not Specified

following locations were monitored for radiological and nonradiological parameters:

Upstream sampling station

- HY, on site, immediately east of the William Floyd Parkway

Downstream sampling stations

- HV, on site, just east of the 10 o'clock experimental hall in the RHIC Ring
- HE, on site, approximately 20 feet upstream of the former STP outfall
- HM-N, on site, at the east firebreak
- HM-S, on site, on a typically dry tributary of the Peconic River at the east firebreak
- HQ, on site, near the site boundary
- HA, first station downstream of the BNL boundary
- Donahue's Pond, off site
- Forge Pond, off site
- Swan Pond, off site, not within the influence of BNL discharges

Control location

- HH, Carmans River

5.5.1 Peconic River – Radiological Analyses

During 2015, radionuclide analyses were performed on surface water samples collected from the ten Peconic River sampling locations and the Carmans River control location. Samples were

Table 5-4. Metals Analysis of Water Samples from BNL On-Site Recharge Basins.

METAL		HO (AGS)		HT-E (a) (AGS)		HT-W (Linac)		HZ (stormwater)		NYSDEC Effluent Limit or AWQS	Typical MDL
Total (T) or Filtered (F)		T	F	T	F	T	F	T	F		
	No. of samples	2	2	2	2	2	2	2	2		
Ag Silver (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	50	2.0
	max.	< 2.0	< 2.0	< 100.0	< 100.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 100.0	< 100.0	< 2.0	< 2.0	< 2.0	< 2.0		
Al Aluminum (µg/L)	*min.*	< 50.0	< 50.0	130.0	< 50.0	< 50.0	< 50.0	< 50.0	< 50.0	2000	50
	max.	94.0	< 50.0	< 2500.0	< 2500.0	62.0	< 50.0	230.0	< 50.0		
	avg.	54.5	< 50.0	< 2500.0	< 2500.0	< 50.0	< 50.0	130.5	< 50.0		
As Arsenic (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	50	5.0
	max.	< 5.0	< 5.0	< 250.0	< 250.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 250.0	< 250.0	< 5.0	< 5.0	< 5.0	< 5.0		
Ba Barium (µg/L)	*min.*	33.0	37.0	38.0	34.0	25.0	25.0	< 20.0	21.0	2000	20.0
	max.	37.0	37.0	130.0	130.0	38.0	36.0	30.0	30.0		
	avg.	35.0	37.0	84.0	82.0	31.5	30.5	23.5	25.5		
Be Beryllium (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	SNS	2.0
	max.	< 2.0	< 2.0	< 100.0	< 100.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 100.0	< 100.0	< 2.0	< 2.0	< 2.0	< 2.0		
Cd Cadmium (µg/L)	*min.*	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	10	2.0
	max.	< 2.0	< 2.0	< 100.0	< 100.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	< 2.0	< 2.0	< 100.0	< 100.0	< 2.0	< 2.0	< 2.0	< 2.0		
Co Cobalt (µg/L)	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5	5.0
	max.	< 5.0	< 5.0	< 250.0	< 250.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	< 5.0	< 5.0	< 250.0	< 250.0	< 5.0	< 5.0	< 5.0	< 5.0		
Cr Chromium (µg/L)	*min.*	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	100	10.0
	max.	< 10.0	< 10.0	< 500.0	< 500.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	< 10.0	< 10.0	< 500.0	< 500.0	< 10.0	< 10.0	< 10.0	< 10.0		
Cu Copper (µg/L)	*min.*	< 10.0	< 10.0	17.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	400	10.0
	max.	< 10.0	27.0	35.0	< 500.0	11.0	< 10.0	25.0	< 10.0		
	avg.	< 10.0	13.9	26.0	< 500.0	< 10.0	< 10.0	17.1	< 10.0		
Fe Iron (mg/L)	*min.*	< 0.05	0.04	0.42	0.10	0.05	< 0.05	0.04	0.03	0.6	0.05
	max.	0.08	< 0.05	< 2.5	< 2.5	0.16	< 0.05	0.33	< 0.05		
	avg.	< 0.05	< 0.05	< 2.5	< 2.5	0.11	< 0.05	0.18	< 0.05		
Hg Mercury (µg/L)	*min.*	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	1.4	0.2
	max.	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
	avg.	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Mn Manganese (µg/L)	*min.*	7.4	6.1	34.0	4.9	3.9	< 2.0	11.0	8.5	600	2.0
	max.	24.0	6.4	110.0	290.0	55.0	4.5	28.0	23.0		
	avg.	15.7	6.3	72.0	147.5	29.5	2.9	19.5	15.8		

(continued on next page)

Table 5-4. Metals Analysis of Water Samples from BNL On-Site Recharge Basins. *(concluded).*

METAL		HO (AGS)		HT-E (a) (AGS)		HT-W (Linac)		HZ (stormwater)		NYSDEC Effluent Limit or AWQS	Typical MDL
Total (T) or Filtered (F)		T	F	T	F	T	F	T	F		
No. of samples		2	2	2	2	2	2	2	2		
Na	*min.*	29.0	40.0	46.0	45.0	28.0	29.0	31.0	27.0	SNS	0.25
Sodium	*max.*	140.0	140.0	6600.0	6700.0	39.0	39.0	720.0	820.0		
(mg/L)	*avg.*	84.5	90.0	3323.0	3372.5	33.5	34.0	375.5	423.5		
Ni	*min.*	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	200	10.0
Nickel	*max.*	< 10.0	< 10.0	< 500.0	< 500.0	< 10.0	< 10.0	< 10.0	< 10.0		
(µg/L)	*avg.*	< 10.0	< 10.0	< 500.0	< 500.0	< 10.0	< 10.0	< 10.0	< 10.0		
Pb	*min.*	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	8.0	< 3.0	50	3.0
Lead	*max.*	< 3.0	7.4	13.0	< 150.0	< 3.0	< 3.0	11.0	< 3.0		
(µg/L)	*avg.*	< 3.0	3.8	7.3	< 150.0	< 3.0	< 3.0	9.5	< 3.0		
Sb	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6	5.0
Antimony	*max.*	< 5.0	< 5.0	< 250.0	< 250.0	< 5.0	< 5.0	< 5.0	< 5.0		
(µg/L)	*avg.*	< 5.0	< 5.0	< 250.0	< 250.0	< 5.0	< 5.0	< 5.0	< 5.0		
Se	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	20	5.0
Selenium	*max.*	< 5.0	< 5.0	< 250.0	< 250.0	< 5.0	< 5.0	< 5.0	< 5.0		
(µg/L)	*avg.*	< 5.0	< 5.0	< 250.0	< 250.0	< 5.0	< 5.0	< 5.0	< 5.0		
Tl	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	SNS	5.0
Thallium	*max.*	< 5.0	< 5.0	< 250.0	< 250.0	< 5.0	< 5.0	< 5.0	< 5.0		
(µg/L)	*avg.*	< 5.0	< 5.0	< 250.0	< 250.0	< 5.0	< 5.0	< 5.0	< 5.0		
V	*min.*	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	SNS	5.0
Vanadium	*max.*	< 5.0	< 5.0	< 250.0	< 250.0	< 5.0	< 5.0	< 5.0	< 5.0		
(µg/L)	*avg.*	< 5.0	< 5.0	< 250.0	< 250.0	< 5.0	< 5.0	< 5.0	< 5.0		
Zn	*min.*	< 10.0	13.0	20.0	10.0	12.0	11.0	19.0	< 10.0	5000	10.0
Zinc	*max.*	13.0	24.0	< 500.0	< 500.0	24.0	13.0	130.0	120.0		
(µg/L)	*avg.*	< 10.0	18.5	< 500.0	< 500.0	18.0	12.0	74.5	60.0		

Notes:
(a) Due to elevated sodium levels in one sample from location HT-E, the sample required a 50 fold dilution to maintain the integrity of the analytical equipment. This resulted in higher than normal detection limits for the metals quantified with this sodium result.
See Figure 5-2 for the locations of recharge basins/outfalls.

AGS = Alternating Gradient Synchrotron
AWQS = Ambient Water Quality Standards
Linac = Linear Accelerator
MDL = minimum detection limit

collected at stations HM-N and HQ once per quarter, as flow allowed. All other stations were sampled semiannually unless conditions (such as no water flow) prevented collection. Stations HE, HM-N, and HQ are equipped with Parshall flumes that allow automated flow-proportional sampling and volume measurements. All other sites were sampled by collecting instantaneous grab samples, as flow allowed.

The radiological data from Peconic River surface water samples are summarized in Table 5-5. Radiological analysis of water samples collected from all locations had very low concentrations of gross alpha and gross beta activity that are attributed to natural sources. All detected levels were below the applicable NYS DWS. No gamma-emitting radionuclides attributable to Laboratory operations were detected, and tritium was not detected above method detection limits in any of the samples.

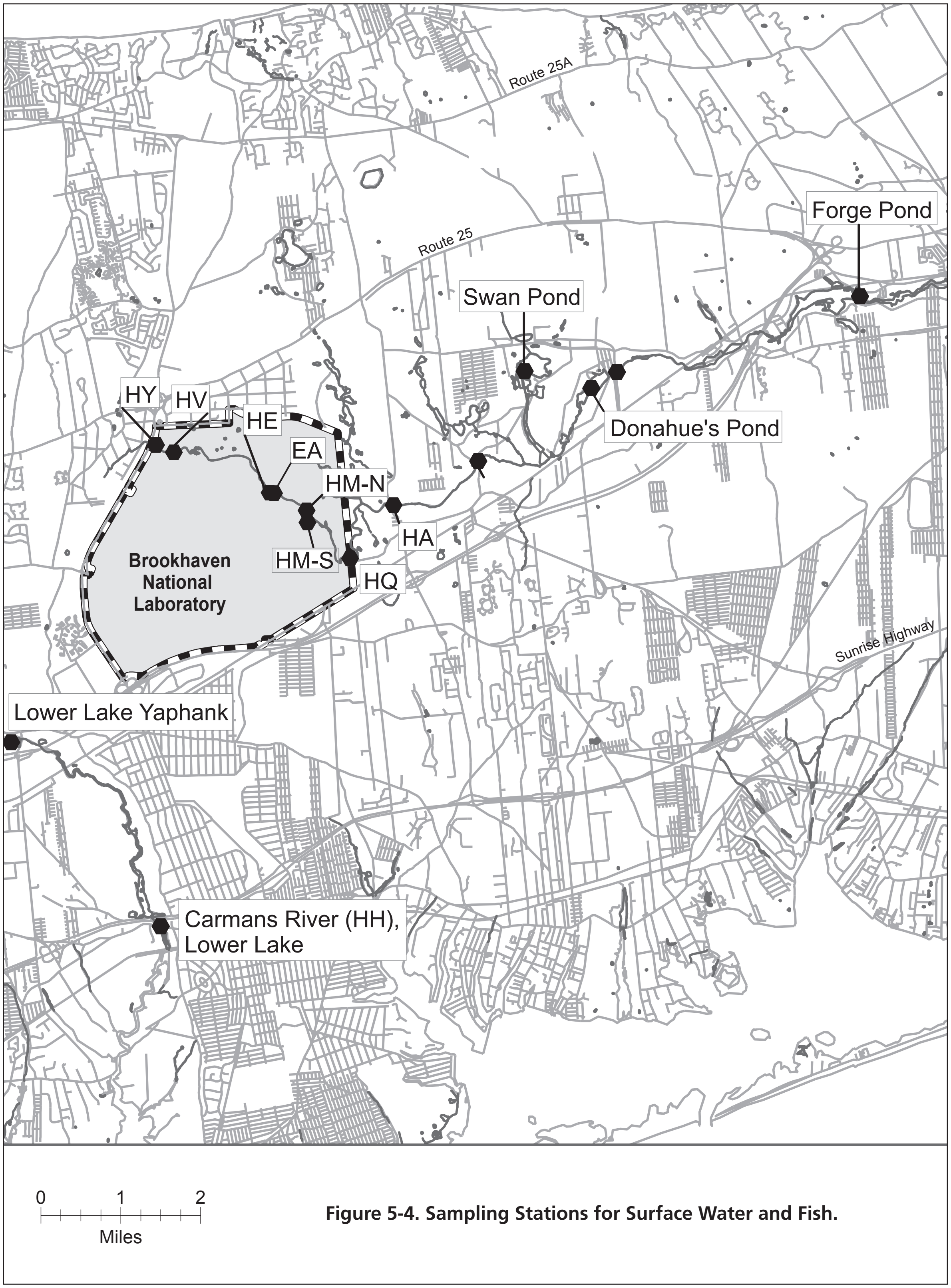

Figure 5-4. Sampling Stations for Surface Water and Fish.

Table 5-5. Radiological Results for Surface Water Samples from the Peconic and Carmans Rivers.

Sampling Station		Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Tritium (pCi/L)	Sr-90 (pCi/L)
Peconic River					
HY (headwaters) on site, west of the RHIC ring	*N*	1	1	1	1
	max	< 18.4	< 3.43	< 386	< 0.32
	avg	NA	NA	NA	NA
HV (headwaters) on site, inside the RHIC ring	*N*	1	1	1	NS
	max	< 10.7	< 2.54	< 434	
	avg	NA	NA	NA	
HE upstream of former STP outall	*N*	1	1	1	1
	max	< 1.36	< 0.87	< 428	< 0.41
	avg	NA	NA	NA	NA
HM-N at east firebreak, on site	*N*	2	2	2	2
	max	1.93 ± 1.25	1.63 ± 0.74	< 357	< 0.32
	avg	1.03 ± 1.77	1.38 ± 0.48	< MDL	0.11 ± 0.03
HM-S tributary, on site	*N*	1	1	1	1
	max	< 1.31	< 0.92	< 430	< 0.35
	avg	NA	NA	NA	NA
HQ at BNL site boundary	*N*	2	2	2	2
	max	< 1.29	1.98 ± 0.66	< 360	0.47 ± 0.25
	avg	0.35 ± 0.07	1.84 ± 0.26	< MDL	0.23 ± 0.46
HA off site	*N*	1	1	1	1
	max	< 1.63	< 0.8	< 437	< 0.42
	avg	NA	NA	NA	NA
Donahue's Pond off site	*N*	2	2	2	2
	max	1.03 ± 0.66	0.95 ± 0.52	< 431	< 0.46
	avg	1 ± 0.05	0.81 ± 0.27	< MDL	0.08 ± 0.23
Forge Pond off site	*N*	2	2	2	2
	max	< 1.36	1.72 ± 0.74	< 428	< 0.42
	avg	0.07 ± 0.36	1.46 ± 0.52	< MDL	0.27 ± 0.28
Carmans River HH control location, off site	*N*	2	2	2	2
	max	< 1.19	< 0.8	< 456	< 0.34
	avg	0.3 ± 0.06	0.63 ± 0.04	< MDL	0.23 ± 0.11
Swan Pond control location, off site	*N*	2	2	2	2
	max	< 1.49	1.56 ± 0.65	< 426	< 0.52
	avg	0.74 ± 0.8	1.44 ± 0.24	< MDL	0.24 ± 0.52
SDWA Limit (pCi/L)		**15**	**(a)**	**20,000**	**8**

Notes:
See Figure 5-4 for the locations of sampling stations.
All values reported with a 95% confidence interval.
Negative numbers occur when the measured values are lower than background (see Appendix B).
To convert values from pCi to Bq, divide by 27.03.
(a) The drinking water standard was changed from 50 pCi/L (concentration based) to 4 mrem/yr (dose based) in 2003. Because gross beta activity does not identify specific radionuclides, a dose equivalent cannot be calculated for the values in the table.
MDL = Method Detection Limit
N = Number of samples analyzed
NA = Not Applicable
NS = Not Sampled for this analyte
RHIC = Relativistic Heavy Ion Collider
SDWA = Safe Drinking Water Act
STP = Sewage Treatment Plant

Monitoring for Sr-90 was performed at all but one Peconic River station and the Carmans River control location in 2015. A sample from Station HV was not collected due to no water flow conditions. Although there was a low-level detection of Sr-90 at sampling station HQ (0.47 ± 0.25 pCi/L), the concentration was well below the NYS DWS of 8 pCi/L. This value is consistent with background levels, and can be attributed to worldwide fallout.

5.5.2 Peconic River – Nonradiological Analyses

River water samples collected in 2015 were analyzed for water quality parameters (pH, temperature, conductivity, and dissolved oxygen), anions (chlorides, sulfates, and nitrates), metals, and VOCs. The analytical data for the Peconic River and Carmans River samples are summarized in Table 5-6 (water quality) and Table 5-7 (metals). There were no VOCs detected above the method detection limits in any samples collected from any of the Peconic River or Carmans River stations in 2015.

With the exception of elevated concentrations of chlorides and sodium in samples collected from upstream Station HY, water quality in the Peconic River was found to be consistent with the Carmans River control location (HH). The elevated levels

Table 5-6. Water Quality Data for Surface Water Samples Collected along the Peconic and Carmans Rivers.

Analyte		Peconic River Station Locations: HY	HE	HM-N	HM-S	HQ	HA	Donahue's Pond	Forge Pond	Swan Pond	(Control) HH	NYSDEC Effluent Standard	Typical MDL
	No. of samples	1	1	2	1	2	1	2	2	2	2		
pH (SU)	*min.*	8.2	6.3	6.4	5.4	6.8	5.5	6.3	7.2	5.4	6.7	6.5-8.5	NA
	max.	8.2	6.3	7.5	5.4	7.5	5.5	7.1	7.5	7.6	7.8		
Conductivity (µS/cm)	*min.*	NA	NA	111	NA	103.0	NA	54	109	40	119	SNS	NA
	max.	2922	98	155	76	183	40	87	178	105	208		
	avg.	NA	NA	133	NA	143	NA	71	144	73	164		
Temperature (ºC)	*min.*	NA	NA	4.0	NA	5.7	NA	3.0	3.8	0.9	6.4	SNS	NA
	max.	4.6	2.5	6.4	2.6	8.1	2.3	19.2	22.8	20.6	18.0		
	avg.	NA	NA	5.2	NA	6.9	NA	11.1	13.3	10.8	12.2		
Dissolved oxygen (mg/L)	*min.*	NA	NA	13.1	NA	12.3	NA	5.8	9.3	8.6	9.6	>4.0	NA
	max.	15.1	11.5	13.5	11.6	13.0	14.4	13.1	13.0	10.0	12.3		
	avg.	NA	NA	13.3	NA	12.6	NA	9.5	11.2	9.3	11.0		
Chlorides (mg/L)	*min.*	NA	NA	20.0	NA	12.0	NA	8.8	17.0	6.2	38.0	250(a)	4.0
	max.	910.0	12.0	27.0	3.9	28.0	6.5	12.0	30.0	16.0	39.0		
	avg.	NA	NA	23.5	NA	20.0	NA	10.4	23.5	11.1	38.5		
Sulfates (mg/L)	*min.*	NA	NA	6.7	NA	5.6	NA	4.4	7.0	1.1	12.0	250(a)	0.5
	max.	5.7	5.3	7.0	2.0	11.0	3.5	5.0	13.0	5.1	12.0		
	avg.	NA	NA	6.9	NA	8.3	NA	4.7	10.0	3.1	12.0		
Nitrate as nitrogen (mg/L)	*min.*	NA	NA	< 0.05	NA	< 0.05	NA	< 0.05	0.01	0.02	1.40	10(a)	0.05
	max.	0.25	0.01	< 0.1	0.10	< 0.05	0.01	0.06	0.16	< 0.05	2.00		
	avg.	NA	NA	< 0.1	NA	< 0.05	NA	< 0.05	0.08	< 0.05	1.70		

Notes:
See Figure 5-2 for recharge basin/outfall locations.
Donahue's Pond = Peconic River, off site
Forge Pond = Peconic River, off site
HA = Peconic River, off site
HE = Peconic River, upstream of former STP Outfall
HH = Carmans River control location, off site
HM-N = Peconic River on site, downstream of former STP Outfall
HM-S = Peconic River tributary, on site
HQ = Peconic River, downstream of former STP Outfall at BNL site boundary
HY = Peconic River headwaters, on site, east of Wm Floyd Pkwy.
MDL = minimum detection limit
NA = not applicable
NYSDEC = New York State Department of Environmental Conservation
SNS = effluent standard not specified
(a) Since there are no NYSDEC Class C surface Ambient Water Quality Standards (AWQS) for these compounds, the AWQS for Class GA groundwater is provided for reference.

Table 5-7. Metals Analysis in Surface Water Samples Collected along the Peconic and Carmans Rivers.

METAL		Peconic River Locations														Swan Pond		Forge Pond		Control HH		NYSDEC AWQS	Typical MDL
		HY		HE		HM-N		HM-S		HQ		HA		DP									
Total or Dissolved		T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D		
No. of samples		1	1	1	1	2	2	1	1	2	2	1	1	2	2	2	2	2	2	2	2		
Ag (I) Silver (µg/L)	*min.*	NA	NA	NA	NA	< 2.0	< 2.0	NA	NA	< 2.0	< 2.0	NA	NA	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	0.1	2
	max.	< 10.0	< 10.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	NA	NA	NA	NA	< 2.0	< 2.0	NA	NA	< 2.0	< 2.0	NA	NA	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Al (I) Aluminum (µg/L)	*min.*	NA	NA	NA	NA	230.0	160.0	NA	NA	200.0	120.0	NA	NA	92.0	62.0	70.0	< 50.0	< 50.0	< 50.0	62.0	< 50.0	100	50
	max.	560.0	< 250.0	310.0	340.0	280.0	160.0	540.0	510.0	240.0	160.0	180.0	170.0	99.0	84.0	190.0	170.0	72.0	< 50.0	80.0	< 50.0		
	avg.	NA	NA	NA	NA	255.0	160.0	NA	NA	220.0	140.0	NA	NA	95.5	73.0	130.0	99.0	54.0	< 50.0	71.0	< 50.0		
As (D) Arsenic (µg/L)	*min.*	NA	NA	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	150	5
	max.	< 25.0	< 25.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	NA	NA	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Ba Barium (µg/L)	*min.*	NA	NA	NA	NA	< 20.0	< 20.0	NA	NA	< 20.0	< 20.0	NA	NA	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	36.0	36.0	SNS	20
	max.	33.0	33.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	25.0	25.0	41.0	42.0		
	avg.	NA	NA	NA	NA	< 20.0	< 20.0	NA	NA	< 20.0	< 20.0	NA	NA	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	38.5	39.0		
Be (AS) Beryllium (µg/L)	*min.*	NA	NA	NA	NA	< 2.0	< 2.0	NA	NA	< 2.0	< 2.0	NA	NA	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	11	2
	max.	< 10.0	< 10.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	NA	NA	NA	NA	< 2.0	< 2.0	NA	NA	< 2.0	< 2.0	NA	NA	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Cd (D) Cadmium (µg/L)	*min.*	NA	NA	NA	NA	< 2.0	< 2.0	NA	NA	< 2.0	< 2.0	NA	NA	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	1.1	2
	max.	< 10.0	< 10.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
	avg.	NA	NA	NA	NA	< 2.0	< 2.0	NA	NA	< 2.0	< 2.0	NA	NA	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0		
Co (AS) Cobalt (µg/L)	*min.*	NA	NA	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5	5
	max.	< 25.0	< 25.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	NA	NA	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Cr (I) Chromium (µg/L)	*min.*	NA	NA	NA	NA	< 10.0	< 10.0	NA	NA	< 10.0	< 10.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	34	10
	max.	< 50.0	< 50.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	NA	NA	NA	NA	< 10.0	< 10.0	NA	NA	< 10.0	< 10.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
Cu (D) Copper (µg/L)	*min.*	NA	NA	NA	NA	< 10.0	< 10.0	NA	NA	< 10.0	< 10.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	4	10
	max.	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	NA	NA	NA	NA	< 10.0	< 10.0	NA	NA	< 10.0	< 10.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		

(continued on next page)

Table 5-7. Metals Analysis in Surface Water Samples Collected along the Peconic and Carmans Rivers. *(continued)*

METAL		Peconic River Locations: HY		HE		HM-N		HM-S		HQ		HA		DP		Swan Pond		Forge Pond		Control HH		NYSDEC AWQS	Typical MDL
	Total or Dissolved	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D		
	No. of samples	1	1	1	1	2	2	1	1	2	2	1	1	2	2	2	2	2	2	2	2		
Fe (AS) Iron (mg/L)	*min.*	NA	NA	NA	NA	0.5	0.3	NA	NA	0.2	0.1	NA	NA	0.5	0.4	0.1	0.1	0.2	0.1	0.4	0.3	0.3	0.05
	max.	1.1	< 0.25	0.4	0.4	0.6	0.3	0.2	0.2	0.2	0.1	0.5	0.3	2.0	2.1	0.4	0.3	0.6	0.4	0.6	0.3		
	avg.	NA	NA	NA	NA	0.5	0.3	NA	NA	0.2	0.1	NA	NA	1.2	1.2	0.3	0.2	0.4	0.2	0.5	0.3		
Hg (D) Mercury (µg/L)	*min.*	NA	NA	NA	NA	< 0.2	< 0.2	NA	NA	< 0.2	< 0.2	NA	NA	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2	0.2
	max.	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
	avg.	NA	NA	NA	NA	< 0.2	< 0.2	NA	NA	< 0.2	< 0.2	NA	NA	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2		
Mn Manganese (µg/L)	*min.*	NA	NA	NA	NA	55.0	23.0	NA	NA	4.4	2.4	NA	NA	54.0	51.0	29.0	21.0	22.0	9.7	50.0	50.0	SNS	2
	max.	30.0	29.0	53.0	65.0	73.0	78.0	26.0	27.0	14.0	12.0	88.0	96.0	180.0	230.0	470.0	450.0	110.0	120.0	150.0	140.0		
	avg.	NA	NA	NA	NA	64.0	50.5	NA	NA	9.2	7.2	NA	NA	117.0	140.5	249.5	235.5	66.0	64.9	100.0	95.0		
Na Sodium (mg/L)	*min.*	NA	NA	NA	NA	13.0	16.0	NA	NA	9.2	9.2	NA	NA	7.1	6.9	5.2	5.3	12.0	13.0	27.0	28.0	SNS	0.25
	max.	540.0	730.0	7.7	9.6	16.0	19.0	3.1	3.2	27.0	27.0	5.6	4.9	8.9	11.0	13.0	13.0	24.0	25.0	30.0	32.0		
	avg.	NA	NA	NA	NA	14.5	17.5	NA	NA	18.1	18.1	NA	NA	8.0	9.0	9.1	9.2	18.0	19.0	28.5	30.0		
Ni (D) Nickel (µg/L)	*min.*	NA	NA	NA	NA	< 10.0	< 10.0	NA	NA	< 10.0	< 10.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	23	10
	max.	< 50.0	< 50.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	NA	NA	NA	NA	< 10.0	< 10.0	NA	NA	< 10.0	< 10.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
Pb (D) Lead (µg/L)	*min.*	NA	NA	NA	NA	< 3.0	< 3.0	NA	NA	< 3.0	< 3.0	NA	NA	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	1.4	3
	max.	< 3.0	< 15.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0		
	avg.	NA	NA	NA	NA	< 3.0	< 3.0	NA	NA	< 3.0	< 3.0	NA	NA	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0		
Sb Antimony (µg/L)	*min.*	NA	NA	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	SNS	5
	max.	< 25.0	< 25.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	NA	NA	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Se (D) Selenium (µg/L)	*min.*	NA	NA	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	4.6	5
	max.	< 25.0	< 25.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	NA	NA	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Tl (AS) Thallium (µg/L)	*min.*	NA	NA	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	8	5
	max.	< 5.0	< 25.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	NA	NA	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		

(continued on next page)

Table 5-7. Metals Analysis in Surface Water Samples Collected along the Peconic and Carmans Rivers *(concluded)*.

METAL		HY		HE		HM-N		HM-S		HQ		HA		DP		Swan Pond		Forge Pond		Control HH		NYSDEC AWQS	Typical MDL
		Peconic River Locations																					
	Total or Dissolved	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D		
	No. of samples	1	1	1	1	2	2	1	1	2	2	1	1	2	2	2	2	2	2	2	2		
V (AS) Vanadium (µg/L)	*min.*	NA	NA	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	14	5
	max.	< 25.0	< 25.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
	avg.	NA	NA	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	NA	NA	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0		
Zn (D) Zinc (µg/L)	*min.*	NA	NA	NA	NA	17.0	19.0	NA	NA	14.0	15.0	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	34	10
	max.	83.0	58.0	19.0	21.0	18.0	28.0	12.0	14.0	16.0	16.0	11.0	< 10.0	< 10.0	< 10.0	18.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
	avg.	NA	NA	NA	NA	17.5	23.5	NA	NA	15.0	15.5	NA	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0		
Zn (D) Zinc (µg/L)	*min.*	21.0	23.0	20.0	18.0	23.0	24.0	15.0	18.0	NA	NA	12.0	15.0	20.0	21.0	< 10.0	11.0	13.0	< 10.0	14.0	14.0	34	10
	max.	42.0	24.0	31.0	41.0	39.0	39.0	30.0	31.0	20.0	21.0	78.0	92.0	81.0	63.0	96.0	< 50.0	63.0	41.0	62.0	68.0		
	avg.	31.5	23.5	25.5	29.5	29.3	28.5	22.5	24.5	NA	NA	45.0	53.5	50.5	42.0	52.6	< 50.0	38.0	25.3	38.0	41.0		

Notes:
See Figure 5-4 for the locations of sampling stations.
AWQS = Ambient Water Quality Standards
AS = Acid Soluble
DP = Donahue's Pond
NA = Not Applicable
SNS = Effluent Standard Not Specified for these elements in Class C Surface Waters
(a) NYS AWQS for Class C surface waters

of chlorides (910 mg/L) and sodium (730 mg/L) detected at Station HY was likely due to road salting operations along the nearby William Floyd Parkway. Although there are no NYS AWQS imposed for chlorides or sodium in discharges to Class C surface waters, the AWQS for chlorides (250 mg/L) and sodium (20 mg/L) in Class GA groundwater can be used for comparison purposes.

Ambient water quality standards for metallic elements are based on their solubility state. Certain metals are only biologically available to aquatic organisms if they are in a dissolved or ionic state, whereas other metals are toxic in any form (i.e., dissolved and particulate combined).

In 2015, the BNL monitoring program continued to assess water samples for both the dissolved and particulate form. Dissolved concentrations were determined by filtering the samples prior to acid preservation and analysis. Examination of the total (i.e., particulate form) metals data showed that aluminum, iron, and zinc were present in concentrations at some locations that exceeded NYS AWQS. Aluminum and iron are detected throughout the Peconic and Carmans River systems at concentrations that exceed the NYS AWQS in both the filtered and unfiltered fractions. Iron and aluminum are found in high concentrations in native Long Island soil and, for iron, at high levels in groundwater. Zinc at concentrations greater than the NYS AWQS was found in a sample collected at sample station HY, which is immediately east of the William Floyd Parkway and not within the influence of BNL operations.

REFERENCES AND BIBLIOGRAPHY

BNL. 2014. Standards Based Management System Subject Area: Liquid Effluents. Brookhaven National Laboratory, Upton, NY. December 2014.

NYCRR Part 703.6. Title 6. 1999. Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations. New York State Department of Environmental Conservation. Albany, NY. Change 8-4-99.