BROOKHAVEN NATIONAL LABORATORY
SOIL AND PECONIC RIVER
SURVEILLANCE AND MAINTENANCE PLAN

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REVISION LOG

Revision	Revision Date	Reason for Revision	Affected Pages
0	May 24, 2006	Original Issue	All
1	March 26, 2013	Included HFBR Waste Loading Area and Waste Transfer Lines, g-2 and BLIP source area caps; added Bldg. 830 and Bubble Chamber; general updates to figures/Appendix B figures, tables, and formatting.	Various
		Removed the Old Firehouse, Recharge Basins HS and HW, Bldg. 208, and Bldg. 464 from the inspections.	Section 1.1.1
		Removed the requirement for performing a radiological walkover survey at the FHWMF every five years.	Section 5.1
		Removed the requirement for collecting and analyzing for radionuclides wetland and terrestrial vegetation samples at the FHWMF.	Section 5.1
		Removed the requirement for annual surface water sampling of the FHWMF wetland and Meadow Marsh for metals.	Section 5.1
		Updated Peconic River post cleanup monitoring requirements for surface water, sediment, and fish; reflected the 2010/2011 supplemental sediment and sediment trap removal; and revegetation/monitoring.	Section 6.0
		Updated Peconic River Sampling and Analysis Plan.	Appendix C

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List of Acronyms

AGS	Alternating Gradient Synchrotron
AOC	Area of Concern
AUI	Associated Universities, Inc.
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
EM	Environmental Monitoring
EPA	U.S. Environmental Protection Agency
ESH	Environment, Safety & Health
FHWMF	Former Hazardous Waste Management Facility
FUA	Facility Use Agreement
GPG	Groundwater Protection Group
IAG	Inter-Agency Agreement
LTRA	Long-Term Response Actions
NYSDEC	New York State Department of Environmental Conservation
O&M	Operation and Maintenance
ORPS	Occurrence Reporting and Processing System
OU	Operable Unit
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation / Feasibility Study
ROD	Record of Decision
S&M	Surveillance and Maintenance
SOP	Standard Operating Procedure
STP	Sewage Treatment Plant

1.0 INTRODUCTION

This Long-Term Monitoring and Maintenance Plan was prepared in support of post-remedial activities for surface projects at Brookhaven National Laboratory (BNL), in Suffolk County, New York. The purpose of this plan is to monitor the long-term effectiveness of soil and sediment remedial actions undertaken in Operable Units (OU) I, III, V, g-2 and the Brookhaven Linac Isotope Producer (BLIP) source area caps, the Waste Loading Area (WLA), and the A/B Waste Transfer Lines at BNL and to assess whether significant impacts to human health, ecological receptors and/or the environment remain.

This plan has been developed to summarize and document information pertaining to BNL remediation areas in OUs I, III, and V that are subject to post-closure monitoring and maintenance activities and/or institutional controls. In addition, the cleanup of the WLA was transferred to the High Flux Beam Reactor (HFBR) scope of work in September 2005 through a modification to the Remedial Design Implementation Plan (RDIP) for the Former Hazardous Waste Management Facility (HWMF). The A/B Waste Transfer Lines remediation scope was also included in the HFBR Record of Decision (ROD). In February 2009, Area of Concern (AOC) 31, comprising the HFBR Complex, the WLA, and the A/B Waste Transfer Lines was established. This plan includes a brief description and background on each AOC within OUs I, III, and V the g-2 and BLIP caps, the WLA, and the A/B Waste Transfer Lines, the institutional controls and monitoring activities associated with each AOC, and their applicable inspection and maintenance activities. This plan defines the scope of work intended within each AOC, so that stewards and stakeholders have a clear understanding of the long-term activities needed to maintain the sites following closure.

1.1 Site Description and Project Background

The United States Department of Energy (DOE) owns the Brookhaven National Laboratory (BNL) site, which is situated on a 5,265-acre tract of land in central eastern Long Island, New York, approximately 60 miles east of New York City. Brookhaven Science Associates (BSA) has been managing and operating BNL under a performance-based contract with DOE since 1998. Land use in the area consists primarily of residential and commercial areas, light industry, and parks.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is the primary driver for environmental remediation of the BNL site. The site was divided into six operable units (OUs) and a Remedial Investigation and Feasibility Study (RI/FS) was conducted for each unit. The locations of AOCs in OUs I, III, and V, the g-2 and BLIP caps, the WLA, and A/B Waste Transfer Lines are shown in Figures 1, 2, and 7. Based on the results of the RI/FS, RODs were issued outlining the selected remedy for each AOC.

BSA's Groundwater Protection Group (GPG), within the Environmental Protection Division, is responsible for ensuring that commitments made in the *OU I ROD* (DOE, 1999b), the *OU III ROD* (DOE, 2000), the *OU V Sewage Treatment Plant (STP) ROD* (DOE, 2001), the *OU V Peconic River ROD* (DOE, 2004), the *g-2 and BLIP ROD* (DOE, 2007), and the *HFBR ROD*

(DOE, 2009), for the WLA and the A/B Waste Transfer Lines, are performed as per this plan. Environmental data are reviewed periodically by BSA's GPG and compiled into a BNL Site Environmental Report (SER) with assessment and conclusions on an annual basis. Five-Year Sitewide Reviews are prepared which evaluate the effectiveness of the remedies. The annual SER summarizes all of the site environmental data. The monitoring requirements in this Plan are subject to change as per the BNL Environmental Monitoring Plan (EMP), which is updated on an annual basis.

BSA conducts and documents field inspections as per Table 2-1 of this plan to assess the conditions of all sites subject to institutional controls. These inspections are conducted to determine whether the current land use remains protective and consistent with all remedial action objectives.

1.1.1 Remedial Histories of AOCs

AOC 1 – Former Hazardous Waste Management Facility (FHWMF)

The FHWMF was used from 1947 to 1997 as a central receiving, processing, and storage facility for radioactive and hazardous waste generated at BNL. As per the OU I ROD, the cleanup objectives for the FHWMF were removal of out of service facilities, tanks, piping, and equipment and excavation and off-site disposal of contaminated soils and sediments above cleanup goals (DOE, 1999b). Cleanup at the FHWMF began in the summer of 2003 with the controlled demolition of several building structures (BNL, 2003d). Removal of approximately 15,000 cubic yards of contaminated soil and debris was completed in September 2005. Remediation of a wetland area on the west side of AOC 1 was completed during the summer of 2005. Following remedial activities, inspections, maintenance, wetlands plant monitoring and maintenance, tiger salamander surveys, and institutional controls were implemented. The location of AOC 1 is illustrated on Figures 1 and 5.

Between 2006 and 2012, a portion of the FHWMF (the WLA) was used as a waste storage and railcar loading area for the Brookhaven Graphite Research Reactor (BGRR) and HFBR decommissioning projects. The WLA is identified in Appendix B. As noted in the discussion below for AOC 31; the WLA was remediated in 2008.

Since 2008, areas of radiologically contaminated soil surrounding the FHWMF, referred to as the FHWMF Perimeter Area, have been remediated. The results of the Phase I cleanup, performed in 2008 and 2009, is documented in the Completion Report (PW Grosser, 2010a). A summary of the Phase II cleanup, performed in 2010, is included in an Addendum Completion Report (BNL, 2010). Additional discrete areas of soil contamination within the FHWMF Perimeter Area that were not addressed in Phase I and II will be investigated and remediated, as necessary, in future remedial efforts, referred to as Phase III.

AOC 2a,d,e – Former Landfill Area

The Former Landfill Area consists of three distinct landfill locations including the Former Landfill (AOC 2a), the Interim Landfill (AOC 2d), and the Slit Trench (AOC 2e) (BNL, 2012a). Given the close proximity of these areas to one another, the term "Former Landfill Area" is used to address these locations collectively. The Former Landfill is an unlined waste disposal area

used from the 1940's through 1966. The Interim Landfill is also unlined and is reported to have been used for one year between the time the Former Landfill was closed, and the Current Landfill (AOC 3) was opened. The Slit Trench is unlined as well, and believed to have operated during the 1960's (CDM Federal, 1996b). In accordance with New York State Department of Environmental Conservation (NYSDEC) regulations, the Former Landfill and Slit Trench were capped in 1996 and the Interim Landfill was capped in 1997 (BNL, 2012a). Surveillance and maintenance (S&M) activities were initiated in 1996 at the Former Landfill and Slit Trench, and 1997 at the Interim Landfill. The location of AOCs 2a, 2d, and 2e are illustrated on Figure 5 and Appendix B.

AOC 2b,c – Chemical Animal Pits/Glass Holes

Fifty-five waste pits were used from the late 1950's to 1981 for the disposal of biological waste, chemical containers, and glassware. In accordance with the OU I ROD, the Chemical Animal Pits/Glass Holes were excavated in 1997 (BNL, 2013) with final off-site disposal of buried chemical and radiological wastes and restoration of the area completed during the summer of 2005. Following remediation, inspections, maintenance, and institutional controls have been implemented. The location of AOCs 2b and 2c are illustrated on Figure 5.

AOC 2f – Ash Pit

The on-site incinerator disposed of incinerator ash in a nearby pit during a period from 1943 to 1963 (BNL, 2013). In accordance with the OU I ROD, a soil cap was installed in 2003 to address the lead-contaminated ash (BNL, 2003c). Following remedial activities, S&M activities and institutional controls were initiated. The location of AOC 2f is illustrated on Figure 5 and Appendix B.

AOC 3 – Current Landfill

The Current Landfill consists of one unlined waste cell that operated from 1967 until the mid-1980's for disposing of waste generated at BNL (BNL, 2012a). In accordance with NYSDEC regulations, the Current Landfill was capped in 1995. S&M activities were initiated thereafter. The location of AOC 3 is illustrated on Figure 5 and Appendix B.

AOC 3a – Wooded Wetland

This area is located adjacent to the Current Landfill (AOC 3) and received runoff from that landfill (P.W. Grosser Consulting, 2001). Sediment and surface water in the wetland periodically contain elevated metals such as mercury and lead. Metals in water are the primary source of absorption by tiger salamanders. In 1999, monitoring of the wetland surface water and sediment was incorporated into the monitoring program for the Current Landfill (AOC 3). The monitoring results for the Wooded Wetlands are presented in the annual Environmental Monitoring Report for the Current and Former Landfill Areas. The wetland is also a tiger salamander habitat and is monitored annually under the *Tiger Salamander Habitat Management Plan* [Appendix A of the *Natural Resource Management Plan* (BNL, 2011f)]. AOC 3a is located east of AOC 3 and is illustrated in Appendix B.

AOC 4 – Sewage Treatment Plant (STP)

BNL's STP processes up to 1.0 million gallons of wastewater per day (BNL, 2013). Treated effluent is discharged into the Peconic River, north of the treatment facility. Concentrations of

heavy metals at the Sludge Drying Beds (AOC 4a) do not pose risks to public health above levels acceptable to EPA (BNL, 2004e). In the past, BNL removed some soils from the sand filter beds (AOC 4b) after accidental releases of contaminants into the beds occurred. The contaminated material from the sand filter beds was piled onto adjacent areas known as sand filter berms (AOC 4b). Concentrations of heavy metals and radionuclides within the sand filter beds and berms do not pose risks to public health above levels acceptable to EPA (BNL, 2004e). However, in order to minimize any potential sources that may possibly leach into the groundwater and the Peconic River, localized removal of elevated levels of mercury and cesium-137 was performed for AOCs 4a and 4b. Excavated wastes were disposed of at a licensed off-site facility in 2003. Following remediation activities, institutional controls, inspections, and maintenance activities were initiated.

The Remedial Investigation had detected elevated levels of radioactivity within the sludge collected at the bottom of the Imhoff Tanks (AOC 4c) (DOE, 2001). In 1995, the sludge in the Imhoff Tanks was removed, treated, and disposed of off-site. In 1997, the Imhoff Tanks and concrete structure were demolished and removed. No further action was required.

The soil and groundwater from the Hold-up Ponds (AOC 4d) do not pose an unacceptable risk to human health or the environment. Long-term groundwater monitoring is being implemented as an institutional control to assure continued effectiveness of the Hold-up Ponds.

In 1985, bromine trifluoride cylinders and two boxes of laboratory chemicals were removed from the Satellite Disposal Area (AOC 4e) (DOE, 2001). The soil and groundwater from AOC 4e do not pose an unacceptable risk to human health or the environment. No further action was required.

The location of AOC 4 and Sub-AOCs 4a, 4b, 4c, 4d, and 4e are illustrated on Figure 6.

AOC 6 – Building 650 Sump and Outfall Area

This facility was used from the late 1950s through the late 1960's to clean radioactive contaminants from clothing and equipment. Water from decontamination of equipment was thought to be discharged into either underground storage tanks or the sanitary sewer system. However, the water was inadvertently discharged at the sump outfall area until 1969 (BNL, 2013). In accordance with the OU I ROD, excavation and off-site disposal of contaminated soils above cleanup goals was completed in 2002 (BNL, 2002c). Following remedial activities, institutional controls, inspections, and maintenance activities were initiated. The location of AOC 6 is illustrated on Figure 1 and in Appendix B.

AOC 8 – Meadow Marsh

This area was used in sewage treatment experiments from 1973 to 1978 (BNL, 2013). Sediments in two of the manmade basins contained elevated levels of heavy metals such as chromium, lead, and mercury. The Meadow Marsh basins were remediated in 2003 and now function as a habitat for tiger salamanders (BNL, 2004a). Following remedial activities, institutional controls, wetland plants monitoring and maintenance, and tiger salamander surveys were initiated. The location of AOC 8 is illustrated on Figure 1.

AOC 10 – Building 811 Waste Concentration Facility (WCF)

This facility has been used since 1949 for reducing the volume of liquid radioactive waste prior to disposal. Building 811 is no longer being used for low-level radioactive liquid waste processing, and the remaining contaminated structures and soils will be addressed when the facility is decommissioned. Three large 100,000 gallon above grade storage tanks (D-waste) were removed in 1994 (IT Corporation, 1995). The remedial action goals of the OU I ROD were to remove the six out of service 8,000 gallon underground storage tanks (A- and B-waste tanks) and associated out of service piping and equipment, and off-site disposal of contaminated soils above cleanup goals (DOE, 1999b). The six tanks and piping were removed during the winter of 2004/2005 and removal and disposal of the soil was completed in 2005 (Weston Solutions, 2005). Since then, the evaporator and piping and pumps in Building 811 have also been removed. As noted in the discussion below for AOC 31, the Building 801 to Building 811 Waste Transfer (A/B) Lines were remediated in 2009 in accordance with the HFBR ROD. Following remedial activities, institutional controls, inspections, and maintenance activities were initiated. The location of AOC 10 is illustrated on Figure 4 and in Appendix B.

AOC 11 and 12 - Bldg. 830 Pipe Leak and Bldg. 830 USTs

Leak tests conducted in 1986 and 1987 revealed that there was a leak in the transfer line located between Building 830 and two 1,000 gallon capacity USTs that were located approximately 75 feet east of the building. The transfer line leak resulted in radionuclide contamination of the soils adjacent to the line. The tanks were removed from service in 1986. The contaminated soils along the transfer line were excavated in 1988. The USTs were completely pumped out in 1994, and the tanks, valve pit pipes and additional contaminated soils were removed in 1999. The excavated areas were backfilled with clean soil and seeded. The location of AOCs 11 and 12 are illustrated on Figure 2.

AOC 14 – Bubble Chamber Spill Area

This area was used for the temporary storage of drum and liquid filled scintillation counters. Scintillation oil is mainly composed of mineral oil and trimethylbenzene. Several documented spills of scintillation oil and transformer oil occurred in this area. Cesspools and septic tanks were removed as part of Removal Action III. Groundwater treatment and monitoring for the OU III plume is ongoing. The location of AOC 14 is illustrated on Figure 2.

AOC 16 – Landscape (Sitewide) Soils

Low levels of cesium-137 were found in soils near several buildings in the center of the BNL site. Surface soils scraped from the FHWMF from 1954 through the mid 1960's were later used as landscaping and fill material at these locations (See Appendix B for the locations) (BNL, 2013). In accordance with the OU I ROD, the soils were excavated and disposed of during the summer of 2000 (BNL, 2001). Following remedial activities, institutional controls, inspections, and maintenance activities were initiated. In 2010 in anticipation of the construction of the new Interdisciplinary Science Building, remaining landscape soils in the area of Former Building 355 (AOC 16.S.5) were excavated and moved to the FHWMF (previously documented to the regulators in 2009/2010). The LUIC website factsheet reflects these activities. As a result, no further inspection of this area is needed; however it will continue to be included in the review of

Laboratory-wide digging permits. The location of AOC 16 is illustrated on Figure 3 and Appendix B.

AOC 16T and 16K – g-2 and BLIP Source Area Caps

As documented in the g-2 and BLIP ROD, in addition to groundwater monitoring for tritium, the selected remedy requires continued routine inspection and maintenance of the concrete/cement/asphalt caps. These inspections are conducted by representatives of the Collider Accelerator Department (C-AD) with reports provided to BSA's GPG. The location of AOCs 16T and 16K are illustrated in Appendix B.

AOC 17 – Low Mass Criticality Facility

The Low Mass Criticality Facility was used for research from the mid-1950's to the mid-1960's, and for temporary drum storage from 1983 to 1984 (BNL, 2013). No contamination at levels of human health concern was found at this location; therefore no cleanup of this area was required. Institutional controls and monitoring are identified in the OU I ROD for this area. This area has been repurposed for use as the OU I Groundwater Treatment System and the recharge basin. The location of AOC 17 is illustrated on Figure 1.

AOC 18 – Alternating Gradient Synchrotron (AGS) Storage Yards

The AGS Storage Yards hold steel and equipment that is being stored for potential reuse at the AGS (BNL, 2013). No contamination at levels of human health concern was found at these locations; therefore no cleanup of this area was required. Institutional controls and inspections will continue. The location of AOC 18 is illustrated on Figure 1.

AOC 21 – Sewer Lines

In the 1940's, approximately 3,400 feet of thirty-inch diameter vitreous clay sewer pipes were installed in the section of the sewer line between Fifth Avenue and the STP (BNL, 2004e). These sewer lines were retired in 1993 and a new line installed parallel to the lines. Sludge, containing elevated levels of americium-241 and cesium-137, was removed from 10 manholes along the retired sewer line in 2002 (BNL, 2004e). The sewer line is capped at both ends and institutional controls will prevent future excavation or damage to the buried sewer lines. The location of AOC 21 is illustrated on Figure 7.

AOC 22 – Old Firehouse

In 1985, a routine radiological survey was conducted near the old firehouse before it was scheduled to be demolished. The survey revealed an area of soil contamination beneath the concrete floor that contained radiation levels that were above background levels. Low levels of cesium-137 and strontium-90 were detected in the soils. In 1985 and 1986 the contaminated soils were excavated to a depth of one foot. The area is currently a grass covered field located east of the NSLS building and west of Renaissance Road. Since the OU III ROD calls for no further monitoring/maintenance, no further inspection of this area is needed; however it will continue to be included in the review of digging permits. The location of AOC 22 is illustrated on Figure 2.

AOC 24e,f – Recharge Basins HS and HW

Recharge Basin HS receives non-contact cooling water and stormwater runoff from the central, developed portion of the BNL site, and Basin HW receives stormwater runoff from the former

warehouse area, now the site of the National Synchrotron Light Source (NSLS) II. Stormwater runoff from the BNL site typically has elevated levels of inorganics and low pH. The basins are known to be tiger salamander habitats. In accordance with the *BNL Environmental Monitoring Plan* and State Pollutant Discharge Elimination System (SPDES) permits, these basins are monitored for water quality, organics, inorganics, and radionuclides. Institutional controls are also implemented in accordance with the *Natural Resource Management Plan* (BNL, 2011d). Since these basins are covered under existing SPDES permits, no further inspections are needed; however they will continue to be included in the review of digging permits. The location of AOCs 24e and 2f are illustrated on Figure 5.

AOC 26b – OU III Building 96 PCB Soils

PCB contaminated surface soils with concentrations up to 4,000 milligrams per kilogram (mg/kg) were identified in the Building 96 former scrap yard (BNL, 2005a). The goal for remedy of the soils was to reduce PCB concentrations to meet the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4046 cleanup objectives. These goals are 1 mg/kg for surface soil without cover material and 10 mg/kg for surface or subsurface soil backfilled with at least one foot of clean cover material. Areas where PCB concentrations in soil ranged between 1 and 10 mg/kg received approximately two feet of clean backfill and topsoil. Following remedial activities in 2005, institutional controls were initiated. Areas that will remain under institutional controls are indicated on the figure showing the Building 96 PCB Soils in Appendix B.

AOC 26a - Building 208

Former Building 208 was demolished and is the current location of the NSLS II. As a result, no further inspection of this area is needed; however it will continue to be included in the review of digging permits. It should be noted that several small oil/water separators still remain beneath the foundations of former warehouse area Buildings 158 and 206. In their current state, the abandoned oil/water separators do not pose any hazards.

AOC 27 – Building 464

The location of the Building 464 former cleanup area for mercury and PCBs is the current location of the Interdisciplinary Science Building. As a result, no further inspection of this area is needed; however it will continue to be included in the review of digging permits.

AOC 30 – Peconic River

The Peconic River receives discharges from BNL's STP. During the remedial investigation, elevated levels of heavy metals (such as mercury, copper, and silver), organic chemicals (such as polychlorinated biphenyls, or PCBs), and low levels of pesticides and radionuclides were detected in the Peconic River sediment (BNL, 2013). In accordance with the *OU V Peconic River ROD* (DOE, 2004), sediments above the cleanup goals were removed and disposed of off-site. The portions of the Peconic River on BNL property were remediated in 2004 (Envirocon, 2005a). The portions of the Peconic River off BNL property were remediated in 2004 and 2005 (Envirocon, 2005b). Following remedial activities, institutional controls, wetlands plant monitoring and maintenance, and water/sediment/fish sampling activities were implemented. As a result of monitoring from 2006 through 2010, two sections of the river and the sediment trap required supplemental sediment remediation. This work was completed in 2011. As discussed in

the approved 2011 Five Year Review (BNL, 2011a and 2011b) and the Final 2010 Peconic River Monitoring Report (BNL, 2011c), modifications to the surface water, sediment, and fish monitoring program were initiated in 2012. The location of AOC 30 is illustrated on Figure 8.

AOC 31 – Waste Loading Area (WLA)

The cleanup of the WLA was completed in 2008 as part of the scope of the HFBR ROD, and was performed as a non-time-critical removal action authorized by the *Action Memorandum, High Flux Beam Reactor, Removal Action for Waste Loading Area* of October 2007. The remediation (by excavation) of this area was performed using the same cleanup goals and methodology required for AOC 1 in the OU I ROD. Approximately 4,560 cubic yards of soil and debris were excavated and disposed of off-site. As noted in the *Final Completion Report, High Flux Beam Reactor Waste Loading Area, Area of Concern 31, Soil Remediation*, July 2009 (PW Grosser, 2009), post remediation surveillance activities include inspections of site fencing, tiger salamander habitat monitoring and surveys, and institutional controls (signs, entry and access restrictions, land use controls, notifications and restrictions, work planning controls such as digging permits, and government ownership). The clean fill and topsoil cover, placed during site restoration, will also be inspected for signs of erosion. See Appendix B for the location of the WLA.

AOC 31 – Waste Transfer Lines (A/B Waste Lines)

The cleanup of the A/B Waste Transfer Lines was completed in 2009 as part of the scope of the HFBR ROD. Site restoration was completed in March 2010. Restoration included backfilling, spreading topsoil, re-grading, re-paving roadways, and reseeding lawn areas with native grasses. Post remediation S&M activities include inspections of the topsoil cover for signs of erosion, and institutional controls (signs, land-use controls, notifications and restrictions, work planning controls such as digging permits, and government ownership). See Appendix B for the location of the A/B Waste Lines.

1.2 Land Use

Brookhaven National Laboratory is a DOE research facility with associated support facilities and is expected to remain so in the foreseeable future. Site Security limits public access to the BNL site.

A future land use study, *Brookhaven National Laboratory Future Land Use Plan* (AUI, 1995) was undertaken and published by DOE in 1995. Potential land uses of the BNL site that could occur after BNL closes as a national laboratory were identified as a mix of open space, industrial/commercial, recreational and residential uses. Additionally, specific post-remediation land use controls are contained within the *Brookhaven National Laboratory Land Use Controls Management Plan* (BNL, 2009) and the BNL *Land Use Controls website* (BNL, 2013).

1.3 Summary of Support Documents

The documents that support this Plan provide further detail and more subject-specific information regarding institutional controls and other post-closure activities. These documents include:

- The Land Use and Institutional Control Factsheets - https://luic.bnl.gov/LUIC/Default.aspx (BNL, 2013) summarize the institutional controls for each AOC.

- The *Current Landfill Operations and Maintenance Manual, Volumes I and II* (CDM, Federal 1996a) provides detailed information on the inspection, monitoring, and maintenance activities necessary to ensure proper performance of the Current Landfill. Key concepts addressed include inspections, maintenance, repair, and environmental monitoring.

- The *Former Landfill Area Operations and Maintenance Manual, Volumes I and II* (CDM Federal, 1996b) provides detailed information on the inspection, monitoring, and maintenance activities necessary to ensure proper performance of the Former Landfill, the Interim Landfill, and the Slit Trench. Key concepts addressed include inspections, maintenance, repair, and environmental monitoring.

- *OU I AOC 16 Final Closeout report for Landscape Soil* (BNL, 2001) provides details of the results of the AOC 16 remediation effort.

- *OU I AOC 2F Final Closeout Report for the Ash Pit* (BNL, 2004f) provides details of the results of the AOC 2F remediation effort.

- *OU I AOC 8 Final Closeout Report for the Meadow Marsh* (BNL, 2004a) provides details of the results of the AOC 8 remediation effort.

- *OU I AOC 1 Former HWMF D&D Final Closeout Report* (BNL, 2003d) provides details of the results of the Building removal phase of the AOC 1 remediation effort.

- *Final Closeout Report Former HWMF Soil Remediation* (Envirocon, 2005c) provides details of the results of the AOC 1 soil and wetland remediation effort.

- *Final Completion Report, Former Hazardous Waste Management Facility Perimeter Area Soil Remediation* (P.W. Grosser, 2010a) provides details of the results of the perimeter area soil Phase I remediation effort.

- *Addendum to the Completion Report for the Former Hazardous Waste Management Facility Perimeter Area Soil Remediation* (BNL, 2010) provides details of the results of the perimeter area soil Phase II remediation effort.

- *OU I Animal/Chemical Pits and Glass Holes Remedial Action Closure Report* (P.W. Grosser 1997) provides details of the results of the AOC 2B and 2C remediation effort.

- *OU I Animal/Chemical Pits and Glass Holes Remedial Action Closure Report Addendum* (BNL, 2005b) details the completion of the waste disposal and removal of soils impacted by waste management activities at AOC 2B and 2C.

- *OU III Bldg. 96 PCB Soil (AOC 26B) Excavation Closeout Report* (BNL, 2005a) provides details of the results of the AOC 26B remediation effort.

- *OU I AOC 6 Bldg. 650 Reclamation Facility Sump and Sump Outfall Closeout Report* (BNL, 2002c) provides details of the results of the AOC 6 remediation effort.

- *OU V Closeout Report Remedial Action AOC 4 STP Sludge Drying Beds and Sand Filter Beds/Berms AOC 21 Abandoned Former Sewerlines* (BNL, 2003f) provides details of the results of the AOC 4 and 21 remediation efforts.

- *OU V Closeout Report Peconic River Phases 1 and 2* (Envirocon, 2005b) provides details of the results of the Peconic River remediation effort.

- *Completion Report, Peconic River Supplemental Sediment Removal* (Terra, 2012) provides a summary of the supplemental sediment remediation activities.

- *Closeout Report, Brookhaven National Laboratory, Operable Unit I, Area of Concern 10, Waste Concentration Facility* (Weston, 2005) provides details of the results of the AOC 10 remediation.

- *Summary of Remediation Actions Taken at Building 830 – Final Update*, (BNL, 1989) provides a summary of the pipe leak remediation effort.

- *Completion Report, Building 830 Underground Storage Tanks Removal Action* (BNL, 1999a) provides the results tank remediation effort.

- *Final Completion Report, High Flux Beam Reactor Waste Loading Area, Area of Concern 31, Soil Remediation* (PW Grosser, 2009) provides details of the AOC 31 remediation effort.

- *Final Closeout Report, Removal of the Building 801-811 Waste Transfer Lines (A/B Waste Lines with Co-located Piping) Area of Concern 31,* (PW Grosser, 2010b) provides details of the AOC 31 remediation effort.

- *Action Memorandum, Building 464 Mercury Soil Remediation*, (BNL, 1994) provides a summary of the soil remediation activities.

2.0 INSTITUTIONAL CONTROLS MONITORING

Institutional controls are important to help minimize the potential for human exposure to and release of residual contaminants, ensuring the protection of human health and the environment. Institutional controls are also important in helping to protect engineered remedies by providing a means to ensure the remedy remains effective, is not showing signs of failure, or is not being vandalized or damaged by outside elements (natural or human) in any way.

Institutional controls at BNL include existing DOE Orders and site-specific procedures. DOE Orders such as *435.1 Radioactive Waste Management* (DOE, 1999a) and *458.1 Radiation Protection of the Public and the Environment* (DOE, 2011) regulate radioactive waste and environmental monitoring. Site specific BNL Subject Areas such as ESH 1.3.6 (Work Planning and Control for Experiments and Operations) ensure that all work at BNL is planned and implemented properly, hazards and risks are identified and controlled, resources are scheduled and coordinated, and appropriate feedback mechanisms are in place. In addition, BNL ESH 1.18.0 (Excavation Safety) Subject Area ensures that, prior to conducting excavation work; BSA's GPG will review the proposed digging location for residual contamination and institutional controls. A background check that includes the history of activities in the vicinity is also required as part of the procedure. *10 CFR 835 Occupational Radiation Protection* and BNL's *Radiological Control Manual* provide radiation protection standards, limits, and program requirements for protecting workers from ionizing radiation. Also, all facilities at BNL have facility use agreements (FUAs) that document the operational safety envelope for that facility.

In addition, any sale or transfer of BNL properties will also meet the requirements of 120(h) of CERCLA to ensure future users are not exposed to unacceptable levels of contamination.

The institutional controls established for each AOC are described in the *Brookhaven National Laboratory Land Use Controls Management Plan* (BNL, 2009) and the BNL *Land Use Controls website* (BNL, 2013). The BNL Land Use Controls website provides GIS based maps of the BNL site illustrating where there are land restrictions for work in certain areas, and provides fact sheets with information on institutional controls for each AOC.

An annual report is submitted to DOE and the regulators documenting the status of the institutional controls.

2.1 Monitoring of Institutional Controls

Institutional controls contain a "monitoring" aspect consisting of inspecting many of the AOCs to assess the effectiveness of the institutional controls, namely access restrictions. Inspections include visual observations to determine if unauthorized work activities or access have occurred (e.g., excavation without proper permits, evidence of trespassing), if re-vegetated areas, soil covers/caps, or fencing requires maintenance, and if postings/signs require updating or replacement. The access restrictions for the AOCs, the monitoring requirements, and the monitoring frequency are provided in Table 2-1. Procedures for inspections are described in Section 3.0.

Table 2-1: Monitoring of Institutional Controls

AOC	Monitoring Requirement	Frequency
1 – Former HWMF Former HWMF Perimeter Soils 10 – Bldg. 811 WCF 31 – Waste Loading Area, A/B Waste Transfer Lines	Inspect fence, gates, signs, and postings. Inspection of areas to determine if unauthorized work activities and/or access have occurred. Inspect remediated areas for signs of erosion of clean fill.	Semiannually (Spring and Fall), and after significant precipitation events*
2b,c – Chemical Animal Pits/Glass Holes 4 – Sewage Treatment Plant 6 – Bldg. 650 Sump & Outfall 16 – Landscape Soils	Inspection of areas to determine if unauthorized work activities and/or access have occurred. Inspect remediated areas for signs of erosion of clean fill. Inspect signs and postings, as appropriate.	Semiannually (Spring and Fall), and after significant precipitation events*
17 – Low Mass Crit. Facility 18 – AGS Storage Yards 21 – OU V Sewer Lines 11 and 12- Bldg. 830 Pipe Leak and USTs 14 – Bubble Chamber Old Incinerator	Inspection of areas to determine if unauthorized work activities and/or access have occurred.	Annually
2a,d,e – Former Landfill Area 3 – Current Landfill	Inspection of cap, drainage systems, fences/gates, and wells per O&M Manuals. Ensure signs are in place.	Monthly
2f – Ash Pits 26b – Bldg. 96 PCB Soil	Inspect soil cover for signs of erosion of clean fill, ensure signs are in place.	Semiannually (Spring and Fall), and after significant precipitation events*
1 – Former HWMF Wetland 3a – Wooded Wetland 8 – Meadow Marsh 30 – Peconic River	Inspection of areas to determine if unauthorized work activities and/or access have occurred. Inspect for erosion.	Semiannually (Spring and Fall), and after significant precipitation events*
16T and 16K - g-2 and BLIP Concrete/Cement/ Asphalt Caps	Inspection of cap, stormwater controls, and unauthorized work.	Semiannually

*Note: Rainfall in which the depth of precipitation is 5 inches or greater in 24 hours.

3.0 INSPECTION CRITERIA

Site inspections are conducted by GPG staff per the frequencies in Table 2-1 to monitor the physical and operational conditions of soil covers, drainage systems, groundwater and soil gas monitoring wells, gas vents, access roads, perimeter fencing, gates, and signs. An inspection checklist, as presented in Appendix A, is completed during the course of each inspection and maintained in the project files. The checklist provides a structured outline to ensure that all portions of the site are properly inspected and that all relevant conditions are well documented. Any element determined to be in a state of deterioration or to require modification will be repaired in accordance with the instructions and typical details provided in Section 4.1. Maps of the AOCs requiring inspections are provided in Appendix B for use in identifying areas requiring repair. DOE is informed of the schedule of inspections and is invited to observe the conduct of the inspections.

Soil Cover - Landfills

For the purpose of inspection, the surface vegetation and slopes are the only apparent design features subject to observation unless erosion has occurred or the soil cover is undergoing repair. Examples of visible damage include erosion of the top soil and protection layers, holes dug by burrowing animals, and tree growth on the cap. In addition, the grass on top of the protective cap should not be allowed to exceed 16 inches in length unless soft ground conditions limit mowing. Soil cover inspections are conducted for AOCs 2a, 2d, 2e, 2f, 3, 6, 10, 16, 16K, 16T, 26b, and 31.

Soil Cover – Fill Material

All other soil remediation areas (AOCs 1, 2b, 2c, 4, 6, 10, 16, 26b, and 31 (WLA and A/B Waste Transfer Lines) are inspected to determine if erosion has occurred to the soil fill. An inspection for erosion is conducted after significant precipitation events (rainfall of 5 or more inches in a 24 hour period). Should significant erosion warranting repair occur, the GPG manager and DOE will be notified and work orders initiated as necessary.

Caps – g-2 and BLIP Source Area Caps

The concrete cap of the g-2 source area (AOC 16T) and the cement/asphalt cap for the BLIP source area (AOC 16K) are inspected semi-annually by C-AD to ensure that water infiltration does not penetrate into the activated soil. The integrity of the caps are inspected and repaired, as necessary. An inspection checklist is completed in accordance with C-AD procedure for Beam Cap Inspections. Reports on the inspections are provided to BSA's GPG.

Drainage Systems

The Landfills utilize drainage systems consisting of drainage channels, toe drains, surface and subsurface drainage pipes, and recharge basins. Specific instructions on inspecting the drainage systems are detailed in the Landfill Operation and Maintenance (O&M) Manuals (CDM Federal, 1996a, 1996b).

Groundwater and Soil Gas Monitoring Wells

Specific instructions on inspecting the groundwater and soil gas monitoring wells, associated with the Landfills, are detailed in the Landfill O&M Manuals (CDM Federal, 1996a, 1996b).

Gas Vents

Specific instructions on inspecting the gas vents, associated with the Landfills, are detailed in the Landfill O&M Manuals (CDM Federal, 1996a, 1996b).

Access Roads

Specific instructions on inspecting the access roads, associated with the Landfills, are detailed in the Landfill O&M Manuals (CDM Federal, 1996a, 1996b).

Fencing

Fence inspections are conducted for AOCs 1 (FHWMF), 3 (Current Landfill), and 10 (Building 811) to prevent inadvertent access. Portions of the fence determined to be cut or otherwise damaged, such that the site is readily accessible, are promptly repaired. Gates observed to be open are locked prior to leaving the areas. Missing locks are replaced immediately. The fencing for Building 650 Sump & Outfall (AOC 6) is not inspected because the fence does not form a complete perimeter.

Postings and Signs

Postings identifying areas of remaining radiologically-contaminated soil are maintained for AOC 10 Building 811 (soil contamination around steam pipes and underground utilities) and also at Building 650 Sump and Sump Outfall (AOC 6) soil contamination adjacent to the 13KV duct bank. Point of contact signs are maintained at AOCs 1, 2, 3, 6, 8, 10, 26b, and AOC 31 (WLA).

Wetlands Plants

The requirements for inspecting wetlands plants are discussed in Section 6.3 of Ecological Monitoring.

4.0 MAINTENANCE SPECIFICATIONS

Post closure maintenance activities will include maintenance and repair of eroded or bare areas where soil caps and soil fill have been installed, maintenance and repair of concrete/asphalt caps, maintenance and repair of fencing and gates, and maintenance of signs and postings. As requested, BNL's Facilities and Operations (F&O) Directorate will conduct maintenance work and minor repairs of the remediated areas. Summaries of repairs performed are documented in the project files. The maintenance requirements for each AOC are provided in Table 4-1.

Table 4-1: Maintenance Requirements

OU	AOC	Name	Maintenance Scope
I	1	Former Hazardous Waste Management Facility	Fencing, gates, soil fill, signs
	2a,d,e	Former Landfill, Interim Landfill, Slit Trench	Soil cover, mowing, drainage systems, groundwater and soil gas monitoring wells, gas vents, access roads, stairs, and signs
	2b,c	Chemical Animal Pits/Glass Holes	Soil fill and signs
	2f	Ash Pit	Soil cover and sign
	3	Current Landfill	Soil cover, mowing, drainage systems, groundwater and soil gas monitoring wells, gas vents, access roads, fencing/gates, stairs, and signs
	3a	Wooded Wetland	None
	6	Bldg. 650 Sump & Outfall Area	Soil fill and signs
	8	Meadow Marsh	Sign
	10	Bldg. 811 Waste Concentration Facility	Soil fill, fencing/gates, radiological control postings, and signs
	16	Landscape Soils	Soil fill
	17	Low Mass Criticality Facility	None
	18	Alternating Gradient Synchrotron Storage Yards	None
	24e,f	Recharge Basin HS and Recharge Basin HW	None
HFBR	31	WLA	Soil fill, fences/gates, and sign
	31	A/B Waste Lines	Soil fill
V	4a	STP Sludge Drying Beds	Soil fill
	4b	STP Sand Filter Beds and Berms	Soil fill
	21	Sewer Lines	None
	30	Peconic River	Gate/lock on Z Path and North Street
III	26b	Bldg. 96 PCB Soil	Soil cover and sign
g-2/ BLIP	16K	BLIP Source Area Cap	Concrete/asphalt cap
	16T	g-2 Source Area Cap	Concrete cap

4.1 Repair and Maintenance Specifications

The physical structure of the soil covers/fill, drainage systems, groundwater and soil gas monitoring wells, gas vents, access roads, and perimeter fencing are maintained and repaired in a manner consistent with as-built conditions throughout the duration of the S&M period. Required maintenance activities, as identified during site inspections, are performed in accordance with the instructions provided in this section. Maps of AOCs 1, 2a, 2d, 2e, 2f, 3, 6, 10, 16, 16K, 16T, 26b, and 31 are provided in Appendix B for use in identifying areas where maintenance and repair are required.

Following site inspections, which indicate deterioration of any portion of the soil covers/fill, drainage systems, groundwater and soil gas monitoring wells, gas vents, access roads, and perimeter fencing, prompt action is taken to repair such conditions to avoid further deterioration. In the event of repair delays, temporary erosion control is utilized, as required, to prevent erosion of the soil caps and drainage structures and silting of the drainage channels, drainage pipes, and recharge areas. Temporary fencing is placed across damaged areas in the fence.

General instructions for repairs to soil covers, drainage systems, groundwater and soil gas monitoring wells, gas vents, access roads, and perimeter fencing are provided in the subsections below. Specific instructions for repairs and material specifications (e.g., seed mixtures, topsoil gradation) are provided in the O&M Manuals or Closeout Reports for the AOCs. These documents were identified in Section 1.3.

4.1.1 Earthwork

Earthen materials used for repair work, unless otherwise specified, must be brought from on-site borrow areas or off-site sources and should be granular, non-frozen, free of angular rocks or other deleterious matter, and as specified in O&M documents, which are listed in Section 1.3. Clean fill shall meet NYSDEC Part 375 requirements prior to use.

All specified lift and compaction requirements for earthen materials are applicable to "large jobs" which may be defined as "jobs that cannot be performed by BNL personnel based upon the volume of work and materials required." For small jobs, compaction testing is not required, however, BNL must make every effort to ensure that materials used for work are well compacted when placed.

If fill material is too dry for proper compaction, the fill layer should be sprayed with a sufficient quantity of clean water to bring the fill layer to the proper moisture content. The maximum moisture content should be limited such that when material is kneaded in the hand, it does not yield free water and placement and compaction can be accomplished without the material pumping or equipment becoming bogged down in the fill. No compaction effort should be made if the fill material is saturated.

Fill material should not be placed, spread, or compacted while the ground or fill material is frozen or thawing, or during unfavorable weather conditions. The fill surface should be made smooth and free from ruts or indentations at the end of any working day when significant precipitation is forecast and/or at the completion of the compaction operations in that area in order to prevent saturation of the fill material.

4.1.2 Drainage Systems

Should drainage systems require repair or replacement, BNL should refer to the specific instructions for repairs and material specifications as provided in Landfills O&M Manuals and the original design specifications (CDM Federal, 1996a, 1996b).

4.1.3 Groundwater and Soil Gas Monitoring Wells

The purpose of the groundwater monitoring wells is to provide sampling points which may be used to monitor groundwater contaminant migration. The purpose of the soil gas monitoring wells is to provide sampling points which may be used to monitor methane and hydrogen sulfide gas migration from the landfills. Monitoring wells are maintained so that the sampling integrity of each well is representative of subsurface conditions at its respective location and is not influenced by environmental factors existing at the ground surface. Monitoring wells determined to be inadequate for groundwater sampling are abandoned in accordance with BNL EM-SOP-104 *Abandonment of Monitoring Wells, Supply Wells, and Remediation Wells*. Groundwater and soil gas monitoring wells determined to be damaged during site inspections are repaired or replaced. BNL should refer to specific instructions for repairs and material specifications as provided in the O&M Manuals and original design specifications (CDM Federal, 1996a, 1996b).

4.1.4 Gas Vents

The purpose of the gas vents is to prevent soil gas generated within the landfills from building up beneath the geomembrane liner by allowing the gas to discharge to the atmosphere. The physical structure of the gas vents shall be maintained throughout the duration of the S&M period. Gas vents determined to be damaged during site inspections are repaired or replaced. BNL should refer to specific instructions for repairs and material specifications as provided in the Landfill O&M Manuals and original specifications (CDM Federal, 1996a, 1996b).

4.1.5 Access Roads

Access roads are maintained and repaired to ensure adequate site access for vehicles and personnel throughout the duration of the S&M period. Should access roads require repair, BNL should refer to specific instructions for repairs and material specifications as provided in the O&M Manuals and original design specifications (CDM Federal, 1996a, 1996b), or as per BNL F&O requirements.

4.1.6 Fencing

Fencing is used in several areas to deter unauthorized access to the remediated areas, prevent passers-by from unintentionally entering the area, and to prevent inadvertent digging in the enclosed area. The fencing is maintained and repaired to remain in as-built condition throughout the duration of the S&M period. Portions of the fencing determined to be damaged during visual site inspections is promptly repaired. BNL should refer to specific instructions for repairs and material specifications as provided in the O&M Manuals for the Landfills (CDM Federal, 1996a, 1996b), or as per BNL F&O requirements.

5.0 ENVIRONMENTAL MONITORING

Monitoring to demonstrate the effectiveness of the cleanups has been performed as documented in the Five-Year Reviews of 2005 and 2010 (BNL, 2011a and BNL, 2011b). Environmental monitoring includes sampling and analysis of groundwater, soil gas, sediment, surface water, and fish. All parameter and frequency requirements stated in Section 5.1 and summarized in Table 5-1 are updated annually in the BNL EMP. Environmental samples are collected in accordance with BNL Environmental Monitoring Standard Operating Procedures (EM-SOP) and are analyzed in accordance with EPA-approved test methods. The specific procedures to be utilized include EM-SOP-600 (Sediment Sampling), EM-SOP-601 (Collection of Soil Samples), EM-SOP-405 (Peconic River Surface Water Sampling for Trace Metals), EM-SOP-701 (Collection of Fish), EM-SOP-704 (LR-24 Electrofisher), EM-SOP-401 (Surface Water and Recharge Basin Sampling), and EM-SOP-503 (Calibration and Use of LANDTEC GEM 2000, for landfill gas collection).

All CERCLA groundwater monitoring is the responsibility of the BNL GPG and is reported to the regulators annually in the SER Volume 2. The details of groundwater monitoring (frequency, analytes, etc.) can be found in the BNL EMP.

5.1 Sampling & Analysis by AOC

<u>AOC 1 – Former Hazardous Waste Management Facility (FHWMF) and Wetland</u>

- As summarized in Chapter 6 of the 2006 BNL Site Environmental Report, as part of post-cleanup monitoring for the FHWMF, five terrestrial and two aquatic vegetation samples were acquired in 2006. Cs-137 was detected at an estimated value of 0.14 pCi/g wet weight in one of the aquatic vegetation samples. It was not detected in any of the other six samples. Vegetation samples were again obtained in 2012 with the collection of two terrestrial and two aquatic samples. Concentrations of Cs-137 ranged from 0.03 pCi/g to 0.39 pCi/g wet weight, which is consistent with background. As a result, no further vegetation samples will be obtained as part of the post remediation monitoring program at the FHWMF.

- When the FHWMF wetland water levels allow, annual surface water samples have been collected and analyzed during the tiger salamander surveys as per *Tiger Salamander Habitat Management Plan* [Appendix A of the *Natural Resource Management Plan* (BNL, 2011d)]. The samples have been analyzed for water quality parameters (temperature, salinity, turbidity, conductivity, and pH). This sampling will continue as part of the BNL Environmental Surveillance Program, and will no longer be included under this post-cleanup monitoring Plan. In addition, wetland water samples have been collected for the last seven years, starting in 2006 and were analyzed for chlorides, nitrates, sulfates, and TAL metals. The data indicate that the average iron concentrations for the seven samples slightly exceeded BNL background values. As a result, no additional surface water samples will be obtained beyond 2013 as part of the post remediation monitoring program at the FHWMF wetland.

AOC 2a,d,e – Former Landfill Area

- The current parameters including the number of wells, analytes, and frequency of groundwater monitoring are identified in the annual BNL EMP. As of January 2013, groundwater sampling is conducted on 14 monitoring wells. Most wells are tested annually for volatile organic compounds (VOCs), PCBs/Pesticides, water quality, total metals, and radionuclides. The results are published annually in the Environmental Monitoring Report for the Current and Former Landfill Areas.

- The current parameters including the number of wells, analytes, and frequency of soil gas monitoring are identified in the annual BNL EMP. As of January 2013, soil gas sampling is performed on 24 wells. The wells are tested semi-annually for methane, lower explosive limit (LEL), and hydrogen sulfide. The results are published annually in the Environmental Monitoring Report for the Current and Former Landfill Areas.

AOC 3 – Current Landfill

- The current parameters including the number of wells, analytes, and frequency of groundwater monitoring are identified in the annual BNL EMP. As of January 2013, groundwater sampling is conducted on 11 monitoring wells. Most wells are tested semi-annually or annually for VOCs, total metals, and landfill leachate parameters, with one well sampled quarterly for VOCs. Starting in 2013, four monitoring wells will continue to be sampled annually for tritium, strontium-90, and gamma. The frequency of monitoring well sampling and the analytical parameters tested for are identified in the BNL EMP.

- The current parameters including the number of wells, analytes, and frequency of soil gas monitoring are identified in the annual BNL EMP. As of January 2013, soil gas sampling is performed on 58 wells. The wells are tested quarterly for methane, LEL, and hydrogen sulfide.

AOC 3a – Wooded Wetland

- Ten years of data from both surface water and sediment sampling within the wooded wetlands indicate a stable pattern in the concentration of metals. Because of this stability, in September 2009, BNL recommended and the regulators concurred that sampling of both surface water and sediment within the wooded wetland complex be reduced to once every 2 years. The most recent sampling was performed in 2012.

- The current parameters including the number of surface water and sediment samples, analytes, and frequency of sampling are identified in the annual BNL EMP. As of January 2013, sampling is conducted on three surface water and sediment samples from the Northern Pond and four surface water and sediment samples from the Southern Pond. The samples are obtained every two years (next in 2014) and analyzed for TAL metals (BNL, 1999b).

AOC 8 – Meadow Marsh

- Annual surface water samples have been collected and analyzed during the tiger salamander surveys as per *Tiger Salamander Habitat Management Plan* [Appendix A of the *Natural Resource Management Plan* (BNL, 20011d)]. The samples have been analyzed for water quality parameters (temperature, salinity, turbidity, conductivity, pH). This sampling will continue as part of the BNL Natural Resource Management Program, and will not be included further under this post-cleanup monitoring plan. In addition, wetland water samples have been collected for the last seven years, starting in 2006 and were analyzed for chlorides, nitrates, sulfates, and TAL metals. The data indicate that mercury exceeded BNL background concentrations in one of the seven samples in 2007. Mercury was not detected in the other six samples. As a result, after the 2013 collection, surface water samples will not be obtained as part of the post remediation monitoring program at the Meadow Marsh wetland.

AOCs 24e,f – Recharge Basins HS and HW

- These basins are monitored under existing SPDES permits by BSA's Environmental Surveillance Program [See BNL EMP and the *Natural Resource Management Plan* (BNL, 2011c)]. No additional monitoring is required under this post-cleanup monitoring plan.

AOC 30 – Peconic River

- As discussed in the Final 2011 Five Year Review (BNL, 2011a, 2011b) and the Final 2010 Peconic River Monitoring Report (BNL, 2011c), following five years of post-cleanup monitoring, modifications to the surface water, sediment, and fish monitoring programs were initiated in 2012. The changes are as follows:

    - BSA/DOE monitors the water-column for total mercury, methylmercury and TSS two times per year at the 15 routine stations between PR-WC-15 (upstream of STP-EFF-UVG) and PR-WC-02. A summary of the Peconic River water column sampling program is provided in Appendix C.

    - BSA/DOE monitors the sediment for total mercury, PCBs and Cs-137 annually at three locations (PR-WC-06, PR-SS-15, and upstream of the former sediment trap). A summary of the Peconic River sediment sampling program is provided in Appendix C.

    - BSA/DOE collects fish samples from four sections of the Peconic River on and off-site of the Laboratory for the analysis of mercury and Cs-137. Fish collected on Laboratory property are also analyzed for PCBs. The collection is performed every two years. No fish were collected in 2012, and the next collection will be performed in 2013. A summary of the Peconic River fish sampling program is provided in Appendix C.

- The above surface water, sediment and fish sampling requirements are also summarized in the 2013 *BNL Environmental Monitoring Plan.* The sampling requirements are

summarized in Tables 5-1 and 6-1 and described in detail in Appendix C. Fish sampling is summarized in section 6.2.

Beginning with the 2012 data, the results of the Peconic River post remediation fish, sediment and water column sampling events will be summarized in the annual SER, which is published by October 1 of the next year. Preparation of a separate annual Peconic River Monitoring Report has been discontinued.

Table 5-1: Sampling & Analysis Requirements[1]

AOC	Name	Medium	No. of Samples	Parameters	Method	Frequency
1	Former HWMF Wetland	Surface water	1	Temperature, salinity, turbidity, conductivity, and pH Sulfate/Chloride/Nitrate/Nitrite TAL Metals Mercury	Field measurements – "YSI" or equivalent EPA Method 300.0 EPA Method 200.8 EPA Method 245.1	Annually*
2a,d,e	Former Landfill / Interim Landfill / Slit Trench	Groundwater	14	VOCs Pesticides/PCBs Sulfates/Chloride/Nitrate/Nitrite TAL Metals Cyanide Gross Alpha/Beta Gamma Spectroscopy Tritium Strontium-90	EPA Method 524.2 EPA Method 608 EPA Method 300.0 EPA Method 200.8 EPA Method 335.2 EPA Method 900.0 EPA Method 901.1 EPA Method 906.0 EPA Method 905.0	Most wells are sampled annually, some semi-annually
		Soil Gas	24	Methane, Lower Explosive Limit (LEL), and hydrogen sulfide.	Field measurements - Landtec GEM 500, MSA 361/Landtec GA-90 or equivalent	Semi-annually
3	Current Landfill	Groundwater	11	VOCs Sulfates/Chloride/Nitrate/Nitrite TAL Metals Cyanide Gamma Spectroscopy Tritium Strontium-90	EPA Method 524.2 EPA Method 300.0 EPA Method 200.8 EPA Method 335.2 EPA Method 901.1 EPA Method 906.0 EPA Method 905.0	Most wells are sampled semi-annually or annually, one well quarterly for VOCs. 4 wells sampled annually for radionuclides.
		Soil Gas	58	Methane, Lower Explosive Limit (LEL), and hydrogen sulfide.	Field measurements - Landtec GEM 500, MSA 361/Landtec GA-90 or Equiv	Quarterly

[1] The number of samples, parameters, and frequency of sample collection represent January 2013 sampling requirements. The most current sampling requirements are identified in the annual BNL EMP.

Table 5-1: Sampling & Analysis Requirements (Continued)

AOC	Name	Medium	No. of Samples	Parameters	Method	Frequency
3a	Wooded Wetland	Surface water	3 - Northern Pond 4 - Southern Pond	TAL Metals Mercury	EPA Method 200.8 EPA Method 245.1	Every two years[2]
		Sediment	3 - Northern Pond 4 - Southern Pond	TAL Metals Mercury	EPA Method 6010B EPA Method 7471	Annually
8	Meadow Marsh	Surface water	1	Temperature, salinity, turbidity, conductivity, and pH Sulfates/Chloride/Nitrate/Nitrite TAL Metals Mercury	Field measurements – "YSI" or equivalent EPA Method 300.0 EPA Method 300.0 EPA Method 200.8 EPA Method 245.1	Annually*
24e	Recharge Basin HS[3]	NA				
24f	Recharge Basin HW[4]	NA				

[2] The next surface water and sediment sampling event at the Wooded Wetland is in 2014.
[3] This recharge basin is monitored under existing SPDES permit by BSA's Environmental Surveillance Program; therefore, no monitoring is performed under this post-cleanup monitoring plan.
[4] This recharge basin is monitored under existing SPDES permit by BSA's Environmental Surveillance Program; therefore, no monitoring is performed under this post-cleanup monitoring plan.

Table 5-1: Sampling & Analysis Requirements (Continued)

AOC	Name	Medium	No. of Samples	Parameters	Method	Frequency
	Peconic River	Surface water	15	Temperature, pH, dissolved oxygen, turbidity River water depth, flow Methylmercury Mercury TSS	Field measurements – "YSI" or equivalent EPA Method 1630 EPA Method 1631E EPA Method SM-20-2540D	Twice annually (June and July)
	Peconic River	Sediment	3	Mercury PCBs Cesium-137	EPA Method 7471a EPA Method 8082 EPA Method 901.1	Annually (May)
30	Peconic River	Fish on BNL property	TBD 2 locations, top and bottom feeders	Temperature, pH, dissolved oxygen, turbidity, conductivity Mercury PCBs Cs-137 Length, weight Age	Field measurements – "YSI" or equivalent EPA Method 7471a EPA Method 8082 EPA Method 901.1 Aging of scales and otoliths	Every two years (spring)[5]
	Peconic River	Fish off of BNL property	TBD 2 locations, top and bottom feeders	Temperature, pH, dissolved oxygen, turbidity, conductivity Mercury Cs-137 Length, weight Age	Field measurements – "YSI" or equivalent EPA Method 7471a EPA Method 901.1 Aging of scales and otoliths	Every two years (spring)

* Sampling at this location will be discontinued after the 2013 collection.

[5] The next fish collection is in 2013.

6.0 ECOLOGICAL MONITORING

The post-cleanup ecological monitoring program was implemented to demonstrate the effectiveness of the cleanup until it was documented in the Five-Year Review of 2010. As a result of the Final 2011 Five Year Review, several changes have been implemented to the post-cleanup ecological monitoring program.

As noted in Section 5.1 above, following five years of post-cleanup monitoring, modifications to the Peconic River fish monitoring program were initiated in 2012. The fish are now collected every other year (next collection in 2013), and sampling locations have been reduced to four. Fish aging will continue. See Section 6.2 for further discussion on fish sampling. Monitoring/control of invasive species in the three areas of the Peconic remediated in 2011 will continue through 2014.

BNL currently executes its *Natural Resource Management Plan*, which is designed to protect and manage flora and fauna and the ecosystems in which they exist (BNL, 2011d). As noted in Section 5.1 above, the ecological health for the remediated area at the FHWMF was determined to be satisfactory; therefore, no further vegetation samples will be obtained as part of the post remediation monitoring program at the FHWMF.

Tiger salamander habitat will continue to be monitored annually at the OU I Wooded Wetland, the FHWMF Wetland, the Meadow Marsh, and Recharge Basins HS and HW, under the *Tiger Salamander Habitat Management Plan* [Appendix A of the *Natural Resource Management Plan* (BNL, 2011d)].

Table 6-1: Ecological Monitoring Requirements[6]

OU	AOC	Name	Assessment Scope	Frequency
I	1	Former Hazardous Waste Management Facility Wetland	tiger salamander surveys	Annually
	3a	Wooded Wetland	tiger salamander surveys	Annually
	8	Meadow Marsh	tiger salamander surveys	Annually
	24e,f	Recharge Basin HS and Recharge Basin HW	tiger salamander surveys	Annually
V	30	Peconic River	Fish Sampling	Every two years[7]
			Wetlands plants monitoring and maintenance	Through 2014

[6] The Lab's Natural Resource Management Program will continue to perform tiger salamander surveys annually at the OU I Wooded Wetland, the FHWMF Wetland, the Meadow Marsh, and Recharge Basins HS and HW, under the *Tiger Salamander Habitat Management Plan* [Appendix A of the *Natural Resource Management Plan* (BNL, 2011d).
[7] The next fish collection is in 2013.

6.1 Tiger Salamander Surveys

In accordance with the *Tiger Salamander Habitat Management Plan* [Appendix A of the *Natural Resource Management Plan* (BNL, 2011d)], the BNL Natural Resource Management Program conducts tiger salamander surveys in on-site ponds and basins that are known to be tiger salamander habitats. The surveys are performed during the developmental stages and according to the associated schedules as follows: counts of egg masses as well as counts of adults during late winter/early spring, and larval counts during late spring/early summer. The specific survey methodologies are defined in the *Tiger Salamander Habitat Management Plan* and survey results are recorded and reported on log sheets provided by the NYSDEC. Results of these activities are covered under a NYSDEC Threatened and Endangered Species Permit, and are submitted to the State annually with a request for permit renewal. Tiger salamander surveys are conducted in AOCs 1, 3a, 8, 24e, and 24f.

The environmental monitoring data collected from the tiger salamander habitats (AOCs 1, 3a, 8, 24e, and 24f), as described in Section 5.0, are used to assess water quality, as it may affect the tiger salamander breeding and larval development.

6.2 Fish Sampling

As noted above, as per the recommendation in the 2011 Five Year Review, modifications to the Peconic River fish monitoring program were initiated in 2012. BSA collects fish samples from four sections of the Peconic River on and off-site of the Laboratory for the analysis of mercury and Cs-137. Fish collected on Laboratory property are also analyzed for PCBs. Scales and otoliths (for brown bullhead) are also collected to determine the age of the fish. The collection is now performed every two years. No fish were collected in 2012, and the next collection will be performed in 2013. A summary of the Peconic River fish sampling program is provided in Appendix C. The following four Peconic River fish sample locations have been selected to include stations that: 1) are accessible for potential fishing, 2) maximize the potential that the station would have sufficient water to support fish, and 3) are in close proximity to surface water and sediment sampling locations.

1. The most upstream Peconic River fish sampling location is the stretch of the river between the BNL STP outfall and stream gauging station HMn. This is remediation Area A. Area A will contain sufficient water to support fish until the STP discharge is redirected to groundwater in 2014. This station is approximately one mile upstream of the site boundary.
2. The second fish sampling location is in the two sections of Area D above and below stream gauging station HQ. The upstream section is on BNL property. The downstream section starts on BNL property and extends into Suffolk County property. This area is directly adjacent to North Street and frequently dries up during periods of low water table. When fish are not available, a backup fish sampling station is the open water section of Area C on BNL property.
3. The third Peconic River fish sampling location will be the section of remediation Area P directly upstream of Schultz Road. Flow is restricted where the river passes through three culverts that run beneath Schultz Road and the location is also downstream of the

confluence of the North and West branches of the Peconic River. This section of the river usually carries sufficient water to support fish.

4. The fourth Peconic River fish sampling station is Donahue's Pond. Donahue's Pond did not require remediation. It is managed by the Peconic Sportsman's Club and is accessible to fishing by its members on a catch and release basis. The water level is controlled by a variable height dam and usually has sufficient water level to support fish.

In addition to the post-cleanup Peconic River collections mentioned above, fish are also collected for the Lab's Environmental Surveillance Program at Lower Yaphank Lake. Due to long-term data sets showing little or no influence from the Laboratory, sampling at Swan Pond and Forge Pond will be discontinued beginning in 2013. Based on the Five-Year Review of the Peconic River cleanup program, fish sampling between post-cleanup monitoring and the Surveillance Monitoring Program will be alternated. Post-cleanup monitoring will occur in odd numbered years (next in 2013) and surveillance monitoring will occur in even numbered years (next in 2014), until such time as the Laboratory no longer discharges effluents to the Peconic River.

Between five to ten fish for each of two species are collected at each area. The goal is to collect a top carnivore, e.g. largemouth bass or chain pickerel, and a bottom feeder, e.g. white sucker or brown bullhead. When fish from these two species and/or trophic levels are not available, substitutions will be made based on availability and size. All fish samples consist of only edible tissue that was removed from the fish (filleted) by the BSA field team. Because the proportion of edible fish tissue to total body weight is highly variable depending on fish size and other factors, the filleted tissue from two or more fish may need to be composited together to obtain sufficient sample mass to obtain mercury, PCB and radionuclide analyses across the size range of Peconic River fish.

All fish samples on BNL property are analyzed for total mercury, PCBs and Cs-137. Samples off of BNL property are analyzed for total mercury and Cs-137 (Table 5-1, and Table C-5 of Appendix C). As noted above, the age of all fish will be determined. Analytical values will be reported as concentration or activity per unit wet weight of fish tissue. Additional details are provided in Appendix C.

6.3 Wetland Plants Monitoring and Maintenance

AOC 1 – Former Hazardous Waste Management Facility (FHWMF)

As noted in Section 5.1 above, based on the 2006 and 2012 vegetation data and visual observations, the ecological health for the remediated area at the FHWMF was determined to be satisfactory; therefore, no further vegetation samples will be obtained as part of the post remediation monitoring program at the FHWMF.

AOC 8 – Meadow Marsh

As part of the Natural Resource Management Program tiger salamander annual surveys, the Laboratory will continue to evaluate the health and vigor of the vegetation at the Meadow Marsh. This includes monitoring of invasive species to maintain and improve tiger salamander habitat.

AOC 30 – Peconic River

In 2007, the NYSDEC determined that the revegetation requirements of the 2004 Peconic River Equivalency Permits were met. Invasive species monitoring and control continued through 2008 to satisfy the federal requirements.

The 2012 Peconic River Wetland Monitoring Report was submitted to the regulators in January 2013. This documents the successful wetland restoration of supplemental sediment removed at three areas in 2010/2011 (PR-WC-06, Sediment Trap, and PR-SS-15). In conformance with the approved 2010 NYSDEC Equivalency Permit, post-transplanting monitoring results indicated all restoration areas achieved the 65 percent cover NYSDEC Equivalency Permit goals; therefore future replanting and vegetation monitoring is not required. Additional restoration maintenance activities included invasive species control completed during two removal events in 2012. *Phragmites australis* was identified and removed from all restoration areas, and no other invasive species were observed. The NYSDEC has reviewed the report, and in a February 26, 2013 letter, agreed that the requirements of the Equivalency Permit have been met and no additional vegetation monitoring is needed.

BSA and DOE will continue to monitor and control the invasive species as necessary (not to exceed 10 percent of cover) an additional two years (through September 2014), to meet the federal duration requirements.

6.4 Peconic River Sediment Trap

As discussed in the 2012 Peconic River Supplemental Sediment Removal Completion Report, the sediment trap was removed as part of the 2010/2011 supplemental sediment remediation. This was a requirement of the Peconic River ROD to reopen the area to fish migration. As noted above, NYSDEC verified that the revegetation requirements have been met. BSA and DOE will continue to monitor and control the invasive species as necessary (not to exceed 10 percent of cover) at the former sediment trap area an additional two years (through September 2014), to meet the federal duration requirements.

7.0 INFORMATION MANAGEMENT

Information pertaining to previously remediated areas is maintained by BSA's GPG in project files. The LUIC website links much of this information (BNL, 2013).

The website provides centralized, integrated access to information pertaining to BNL remediation areas that are subject to land use and institutional controls. It includes brief historical summaries (fact sheets) on each of the BNL contaminated sites and facilities, their cleanup status, contaminants of concern, and maps depicting land use and land use restrictions. It defines the scope of activities intended within each contaminated area, so that stewards and stakeholders have a clear understanding of restrictions and stewardship responsibilities.

Information that is needed for institutional controls and reporting will be retained and managed by BSA's GPG which includes data documenting past remedial activities. In addition, newly acquired information or data related to remedy performance will be readily available to stakeholders and the public. Many key CERCLA decision documents can be accessed on the BNL website.

8.0 REPORTING

8.1 Routine Reporting

BSA/DOE issues an annual letter report to the IAG members providing information on monitoring of institutional controls, maintenance, site inspections, and corrective actions. BSA/DOE provide conclusions on whether the institutional controls are functioning properly and are protective as designed. Starting with the 2012 report, this report includes review of the institutional controls for the g-2 and BLIP caps, as well as the BGRR and HFBR.

The results of the Peconic River post remediation sediment, water column, and fish sampling, as well as vegetation monitoring are evaluated and presented in the annual BNL SER.

8.2 Non-Routine Reporting

BSA/DOE will notify the IAG members of any institutional control breaches in accordance with the BNL Land Use Controls Management Plan, BNL, 2009.

Minor maintenance actions such as seeding small areas, minor erosion repairs on the soil capped areas, replacement of postings and signs, minor fence and gate repairs, and minor maintenance of site infrastructure will not be subject to the notification process described above.

8.3 Landfills Environmental Monitoring Report

BSA/DOE submits an Environmental Monitoring Report for the Current and Former Landfill Areas to the NYSDEC and EPA on an annual basis documenting operation, maintenance, and monitoring activities for the Former Landfill Area (AOCs 2a, 2d, and 2e) and the Current Landfill Area (AOCs 3 and 3a) (BNL, 2012a). The report contains a summary of sampling activities, repair work performed, data, discussions, conclusions, and recommendations. The results of the Wooded Wetlands sampling (every two years) are also included in the report.

8.4 Site Environmental Reports

The BNL *Site Environmental Reports* are prepared to inform regulators, the public, BNL employees, and other stakeholders of BNL's environmental performance for the calendar year (BNL, 2012b). The report is prepared in accordance with the DOE Order 231.1B, Environment, Safety and Health Reporting of the DOE, and summarizes BNL's performance in the areas of environmental management, environmental impacts, compliance with applicable regulations, surveillance monitoring, and restoration.

8.5 Tiger Salamander Survey Reports

The results of tiger salamander surveys are recorded and reported on log sheets provided by the NYSDEC, as required under Endangered/Threatened Species License Number 195. Annual reports as required by permit are submitted to the Special License Unit of the NYSDEC.

8.6 CERCLA Five-Year Review

Under CERCLA, a review of the remedies at BNL is required at least every five years. The CERCLA Five-Tear Reviews include focus on the protectiveness of all remedies at BNL. The institutional controls portion of the CERCLA Five-Year Review Report include summaries of the inspections conducted at BNL during the five-year period and a discussion of the effectiveness of the institutional controls. If a determination is made that a particular control is not meeting its objectives, then planned corrective actions will be included in the report.

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FIGURES

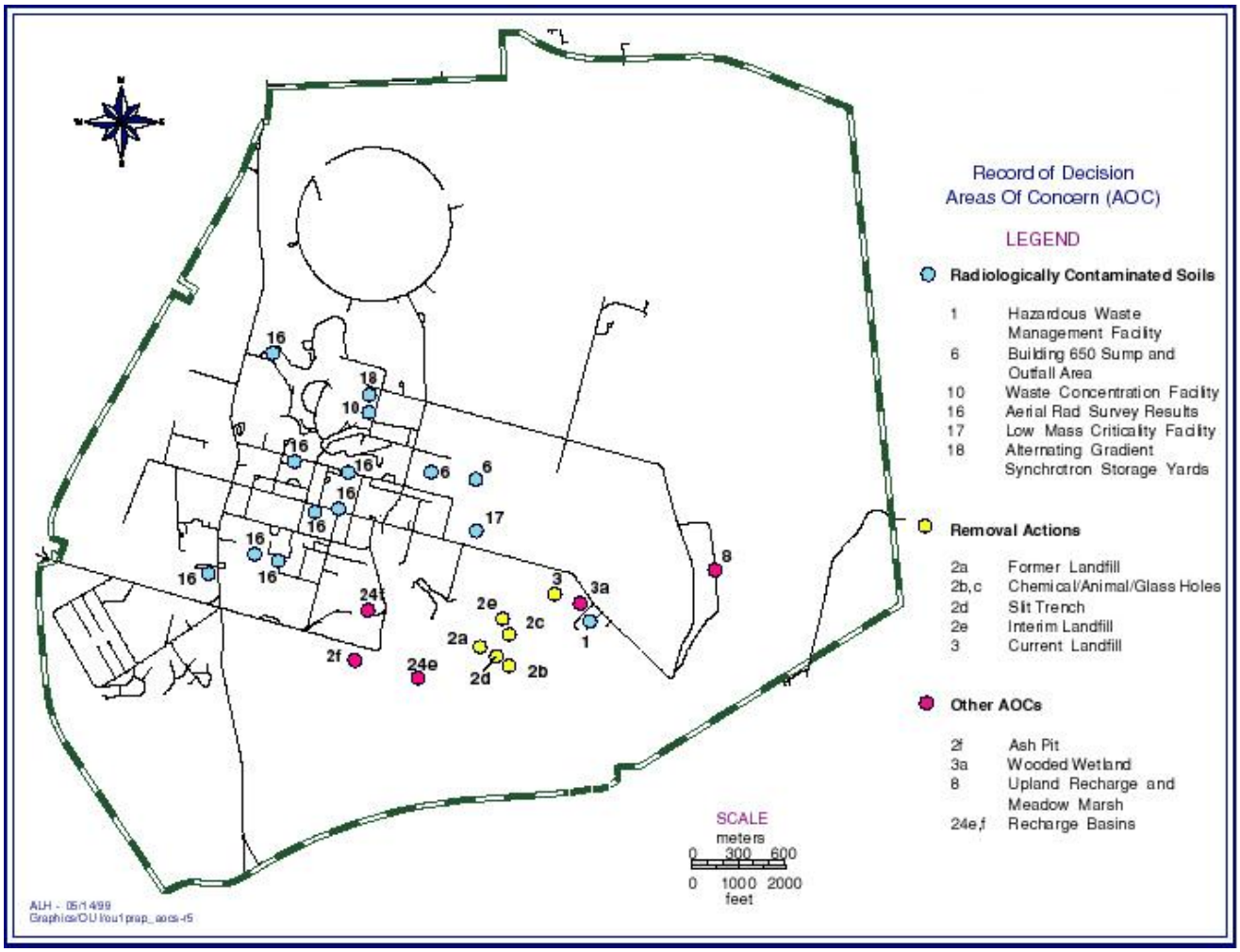


Figure 1: Operable Unit I Areas of Concern

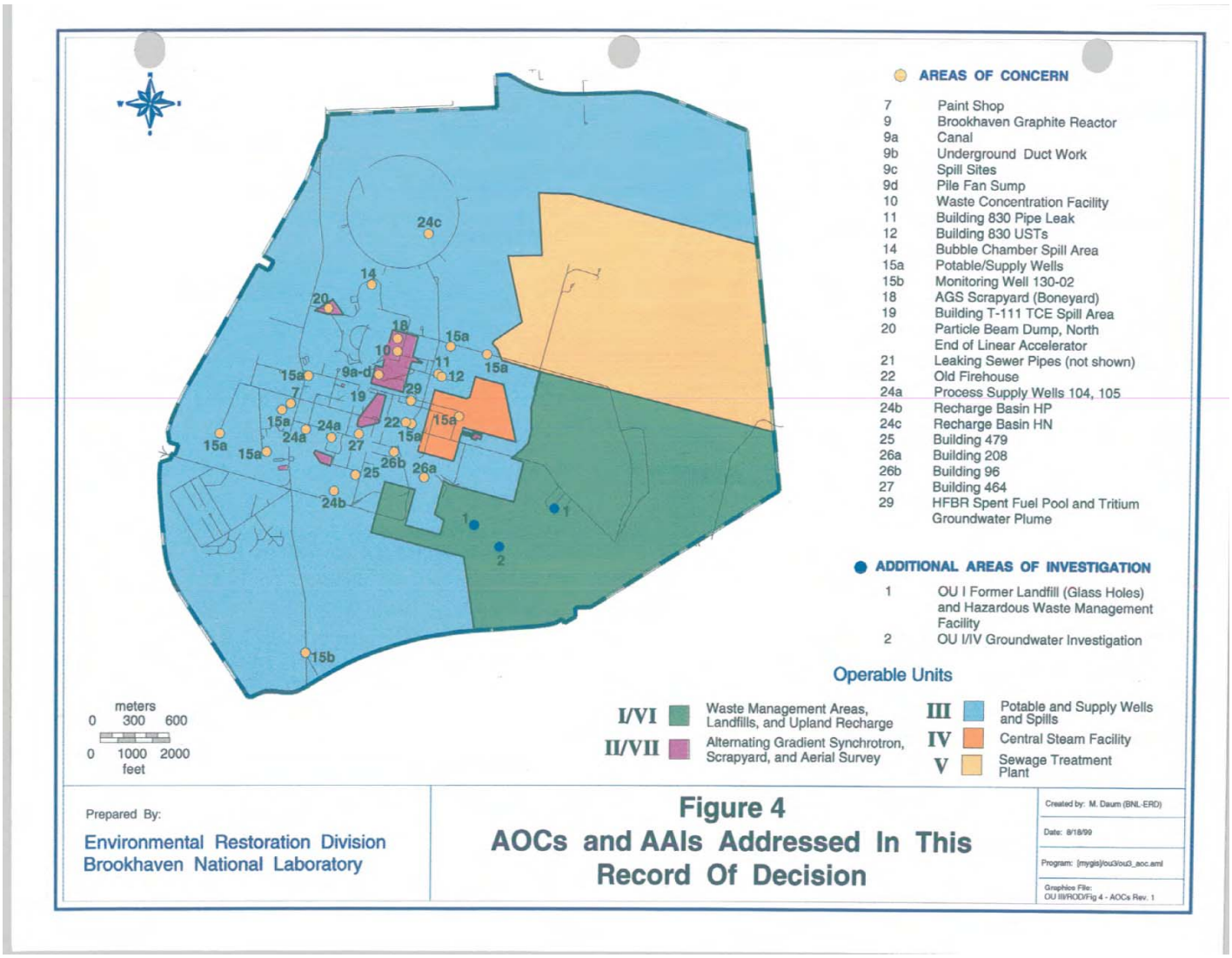


Figure 2: Operable Unit III Areas of Concern

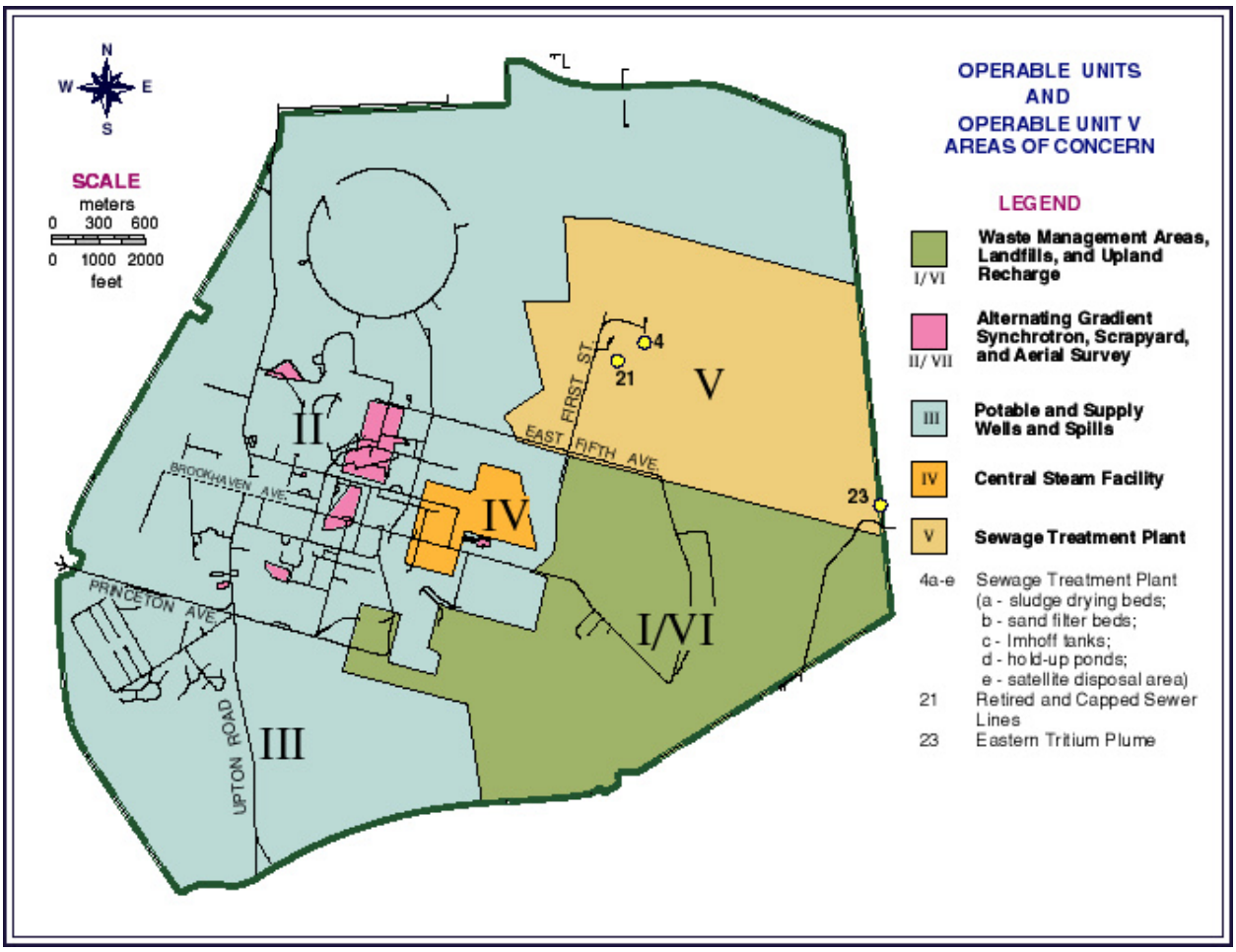


Figure 3: Operable Unit V Areas of Concern

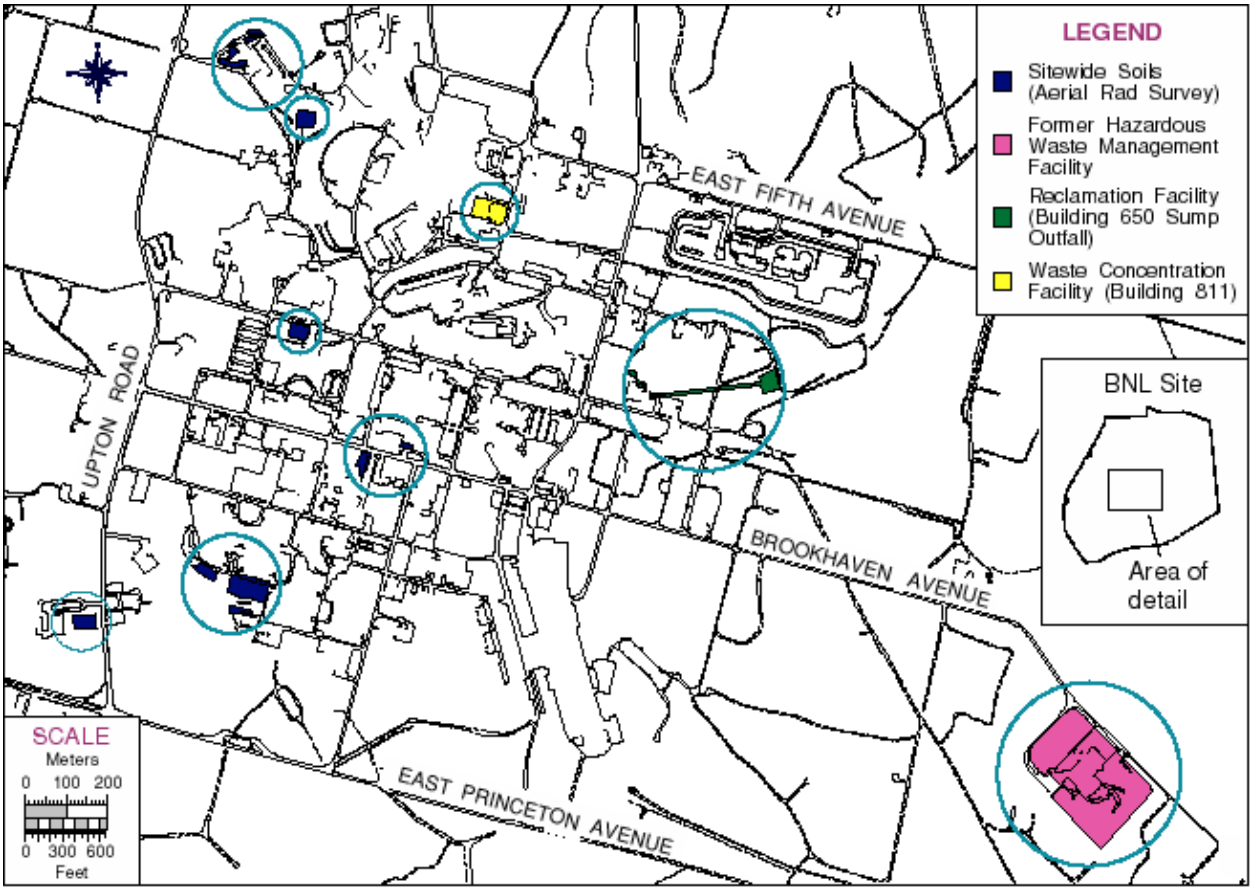


Figure 4: AOCs 1, 6, 10, and 16

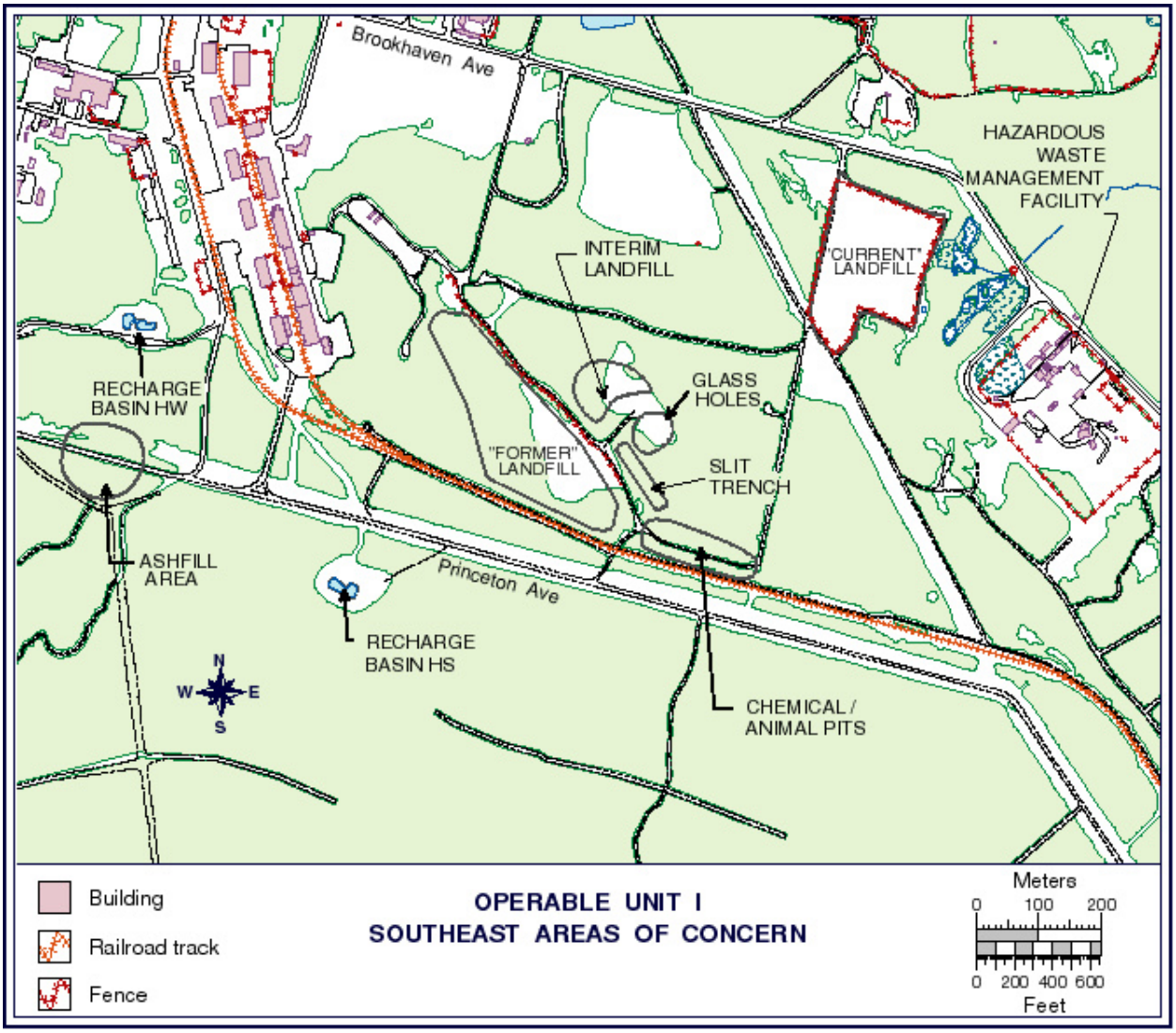


Figure 5: AOCs 1, 2a-2f, 3, 3a, 24e, and 24f

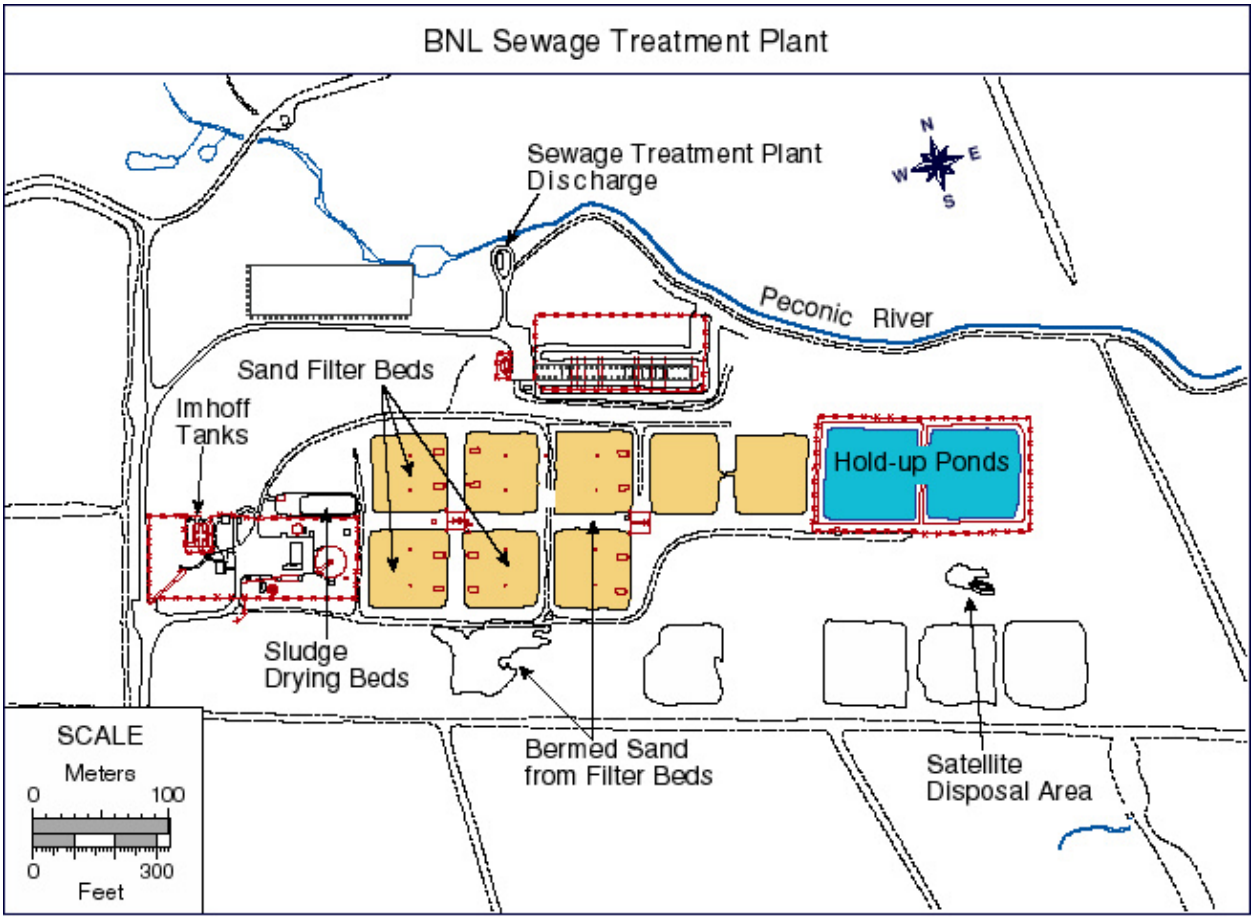


Figure 6: AOCs 4a, 4b, 4c, 4d, and 4e

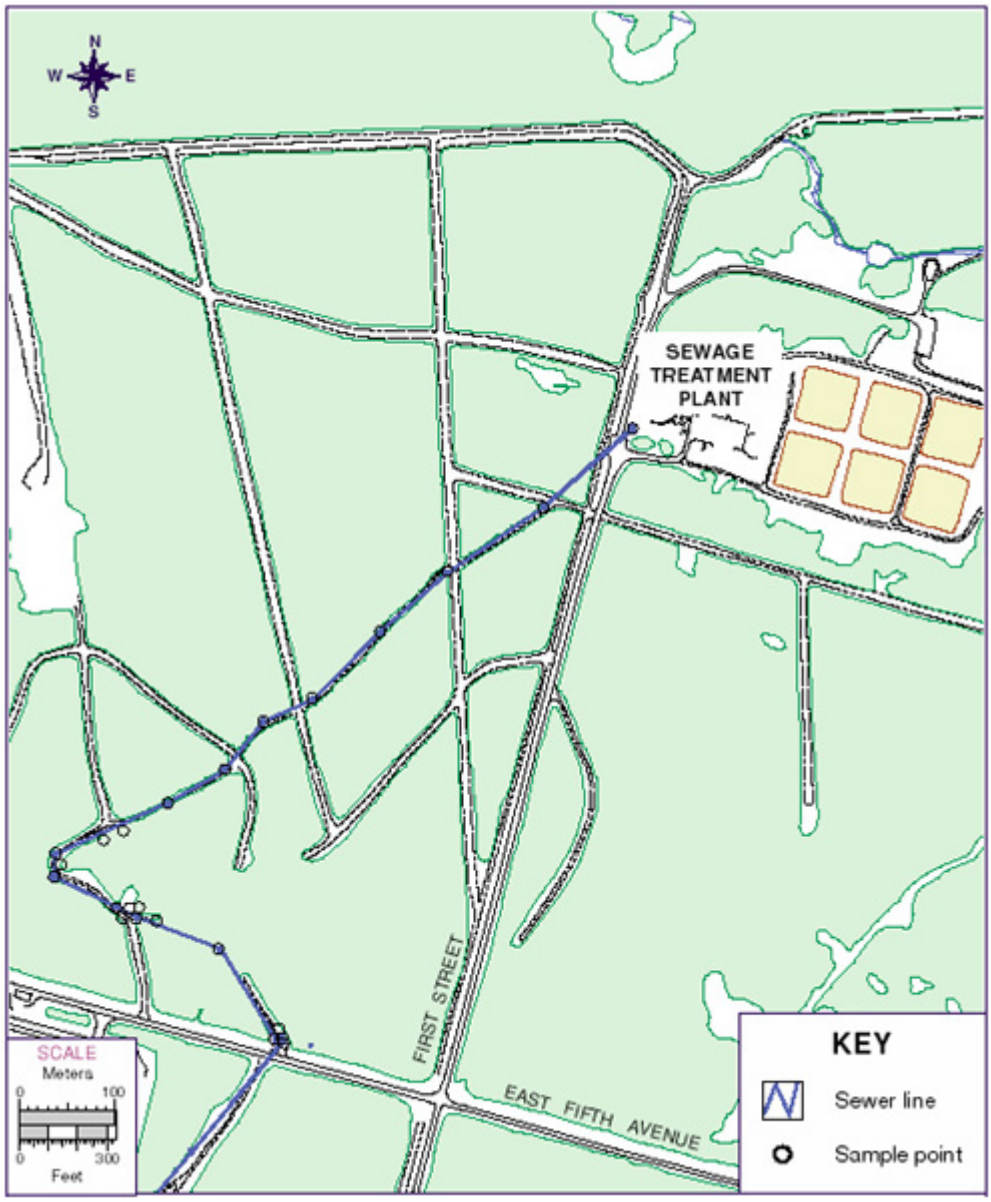


Figure 7: AOC 21 Sewer Lines

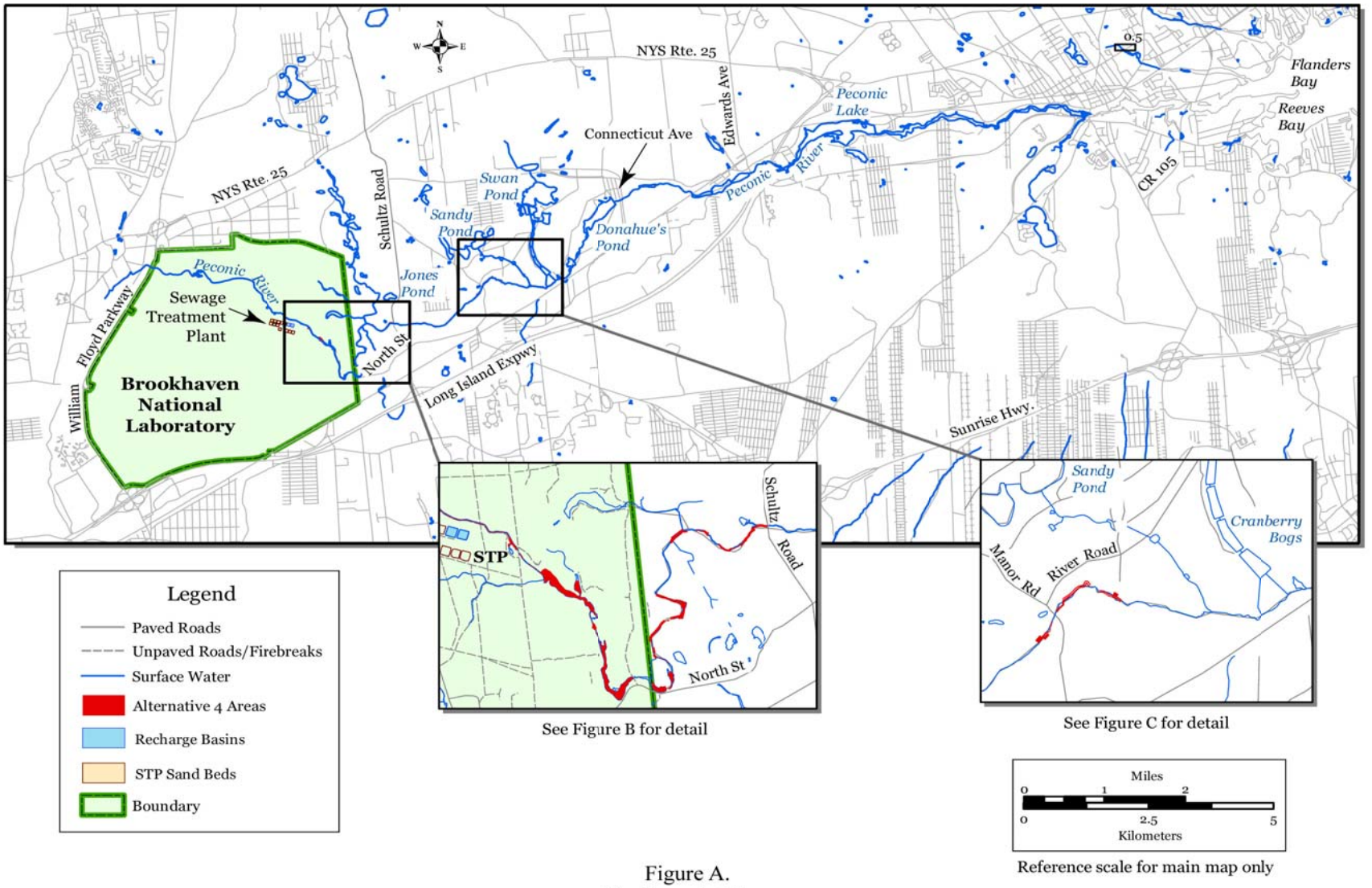


Figure A.
The Peconic River

Figure 8. The Peconic River (AOC30). Areas that were remediated are indicated in the two call-out boxes, and are shown in detail in Figures 8A and 8B.

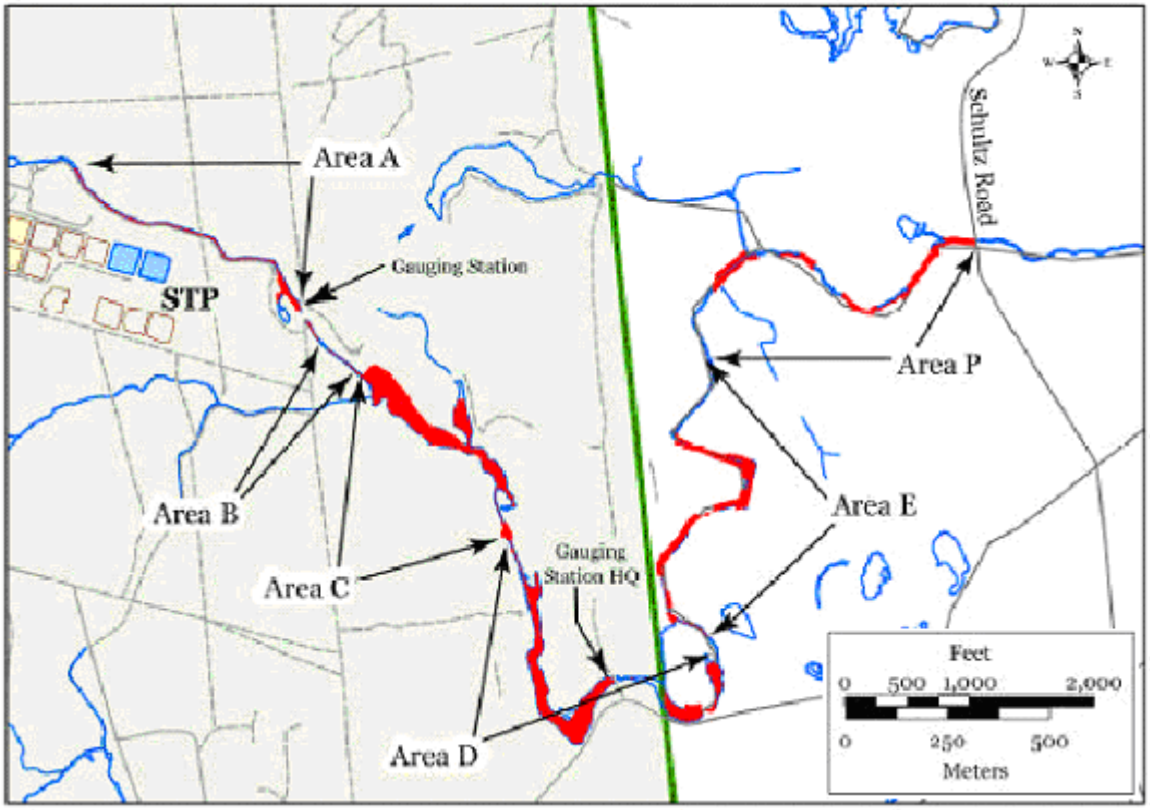


Figure 8A: AOC 30 Peconic River (BNL STP to Schultz Road)

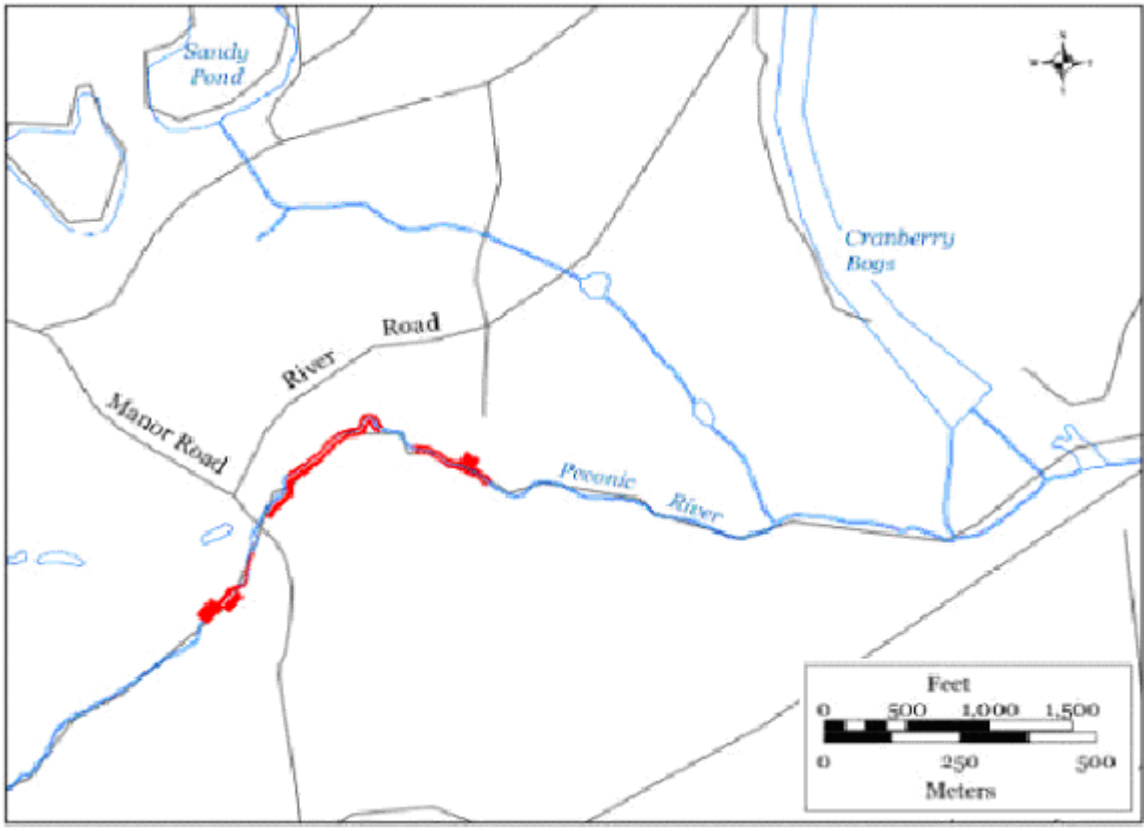


Figure 8B: AOC 30 Peconic River (Manor Road)

APPENDIX A

BROOKHAVEN NATIONAL LABORATORY
SITE INSPECTION FORM

Location (AOC): _____

Date of Inspection: _____
Name of Inspector(s):
Purpose of Inspection: ☐ Routine (Scheduled Frequency of _____) ☐ Heavy Rainfall ☐ Reported Incident

A. Inspection Checklist

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

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

B. Description of Other Observations

Observed Conditions/Recommendations: _____

_____

_____

BROOKHAVEN NATIONAL LABORATORY
MAINTENANCE AND REPAIR FORM

Maintenance for Location (AOC): _____

Date of Repair: _____

Condition to be repaired: _____

_____

_____

_____

_____

_____

_____

Description of Work Performed and by Who: _____

_____

_____

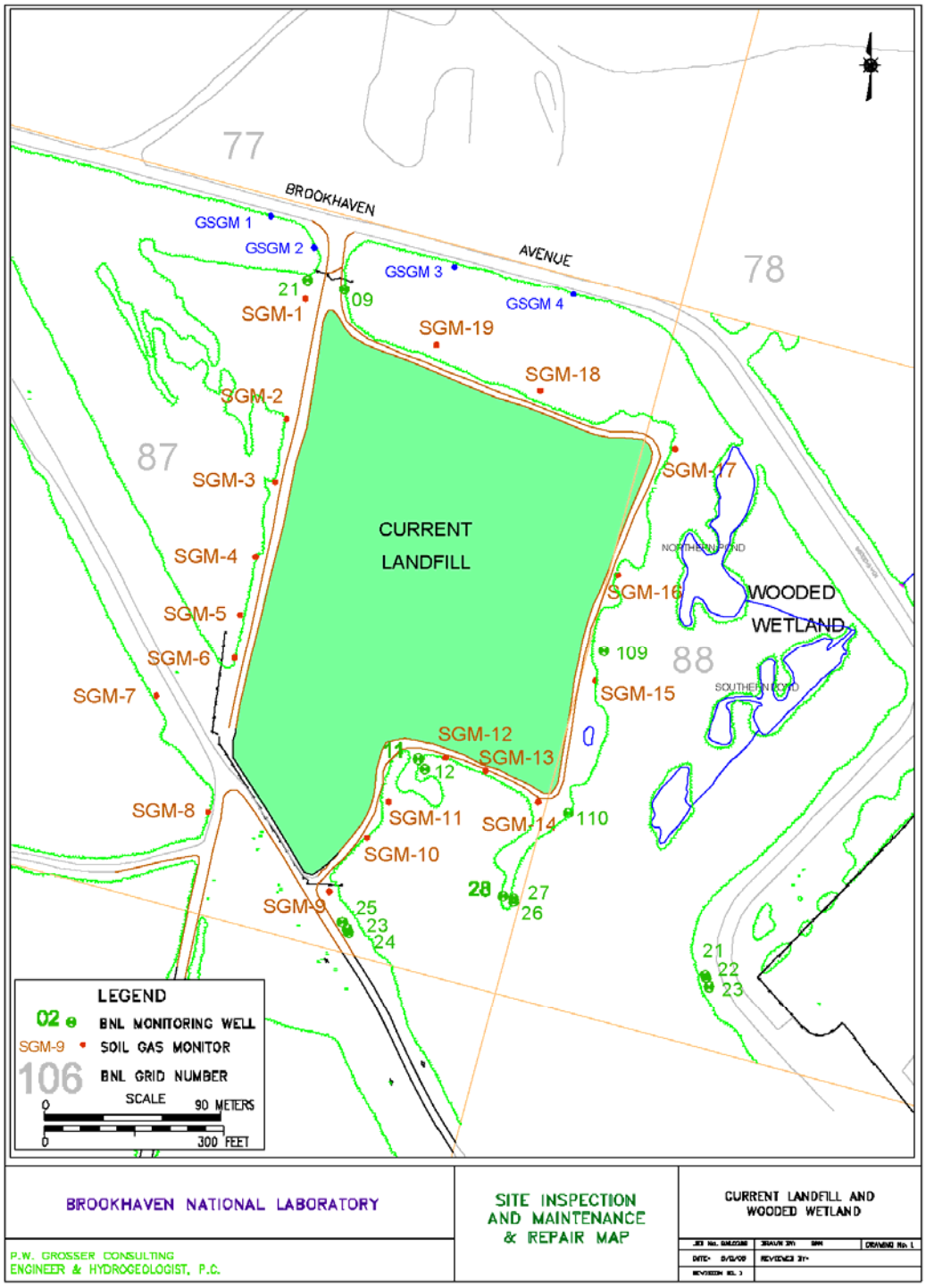
_____

_____

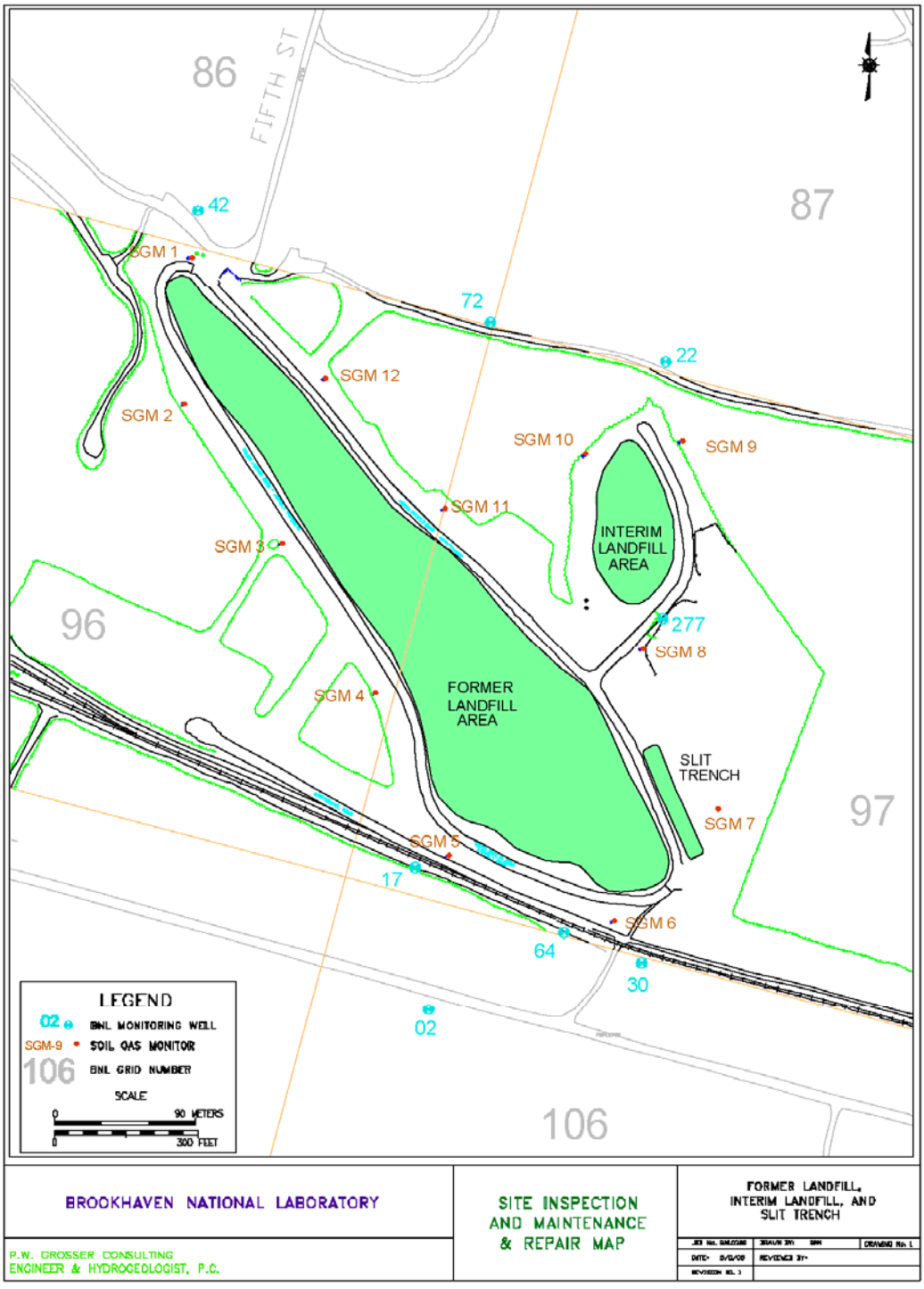
_____

APPENDIX B

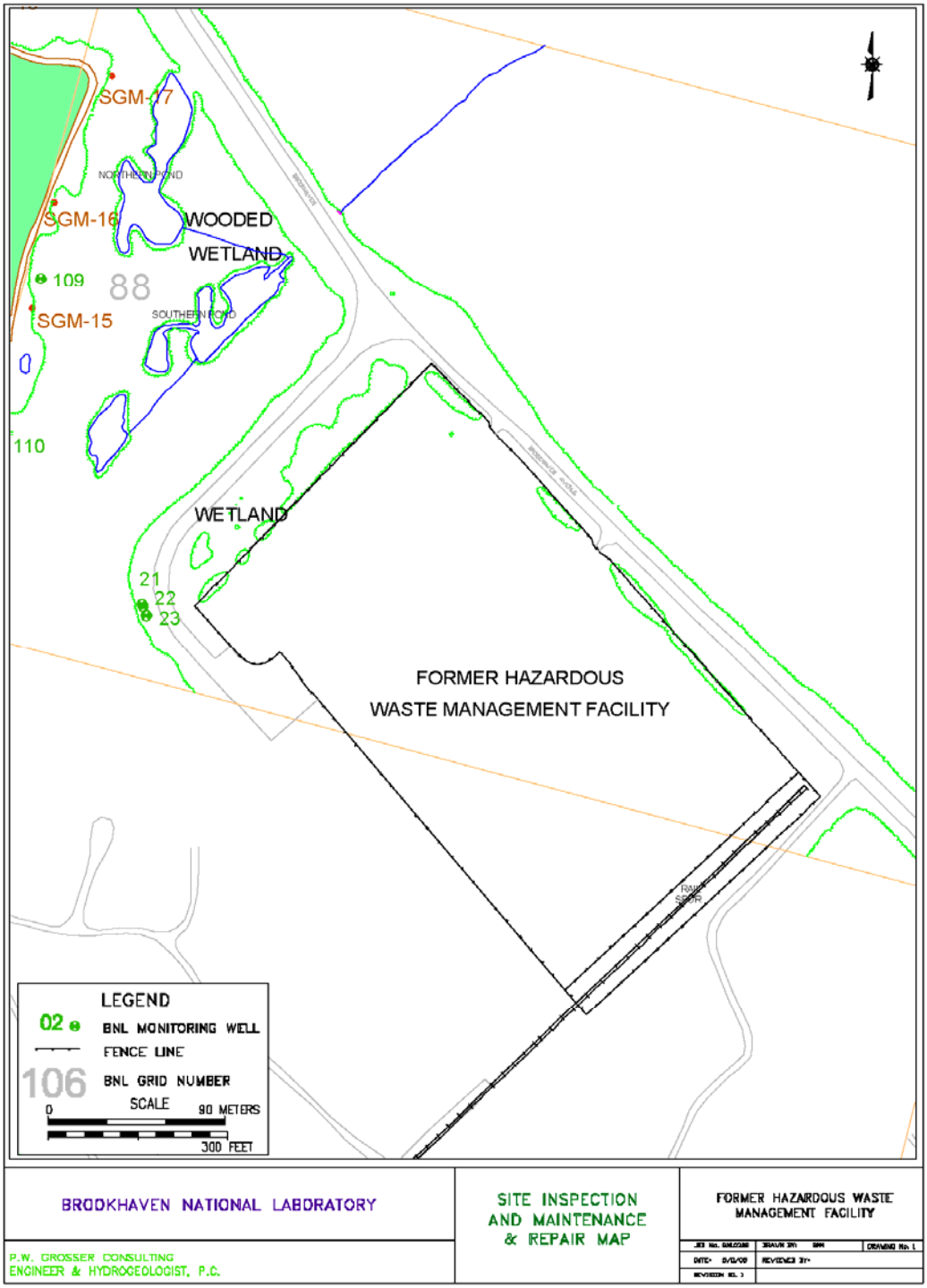
Current Landfill



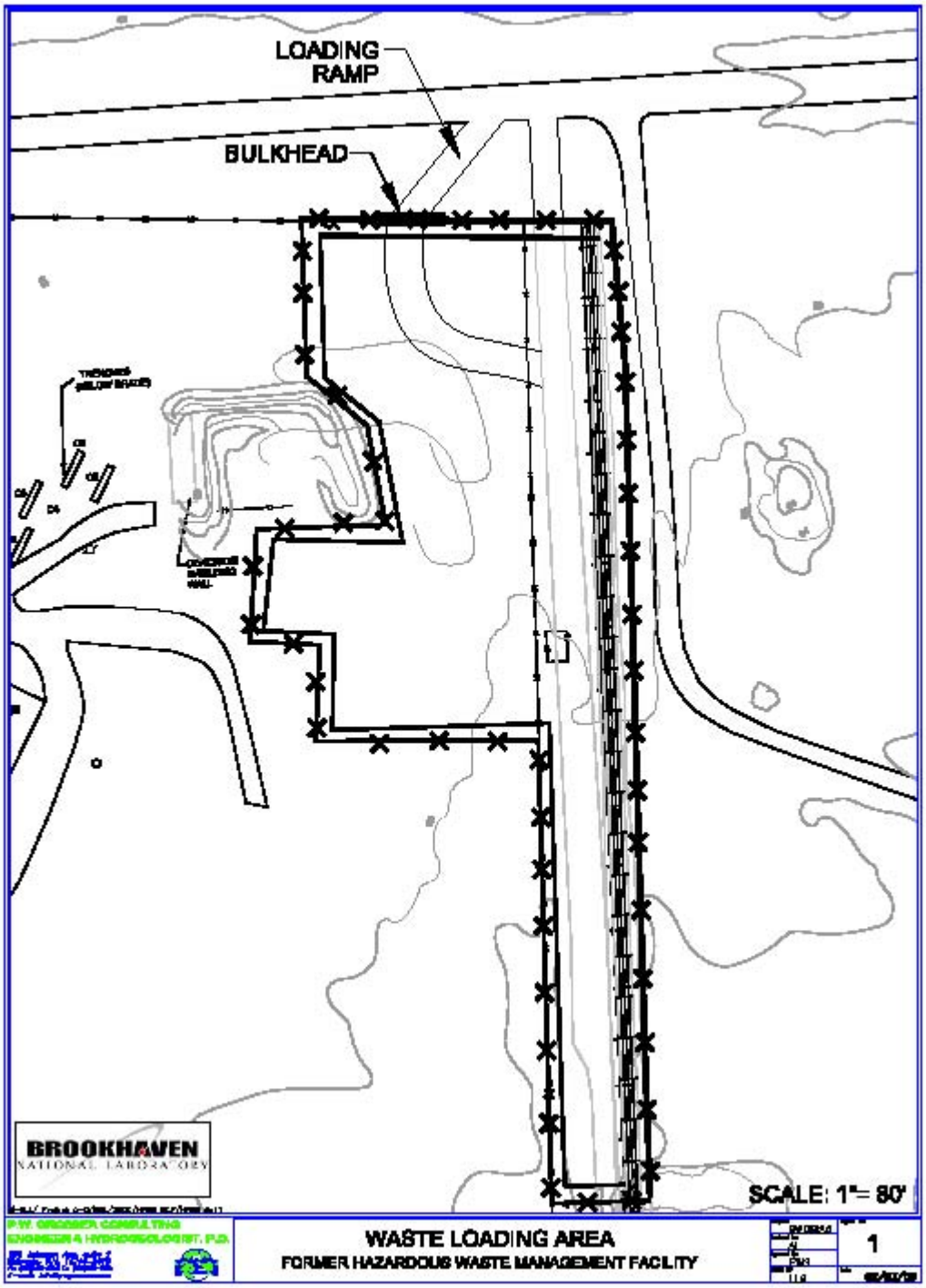
Former Landfill



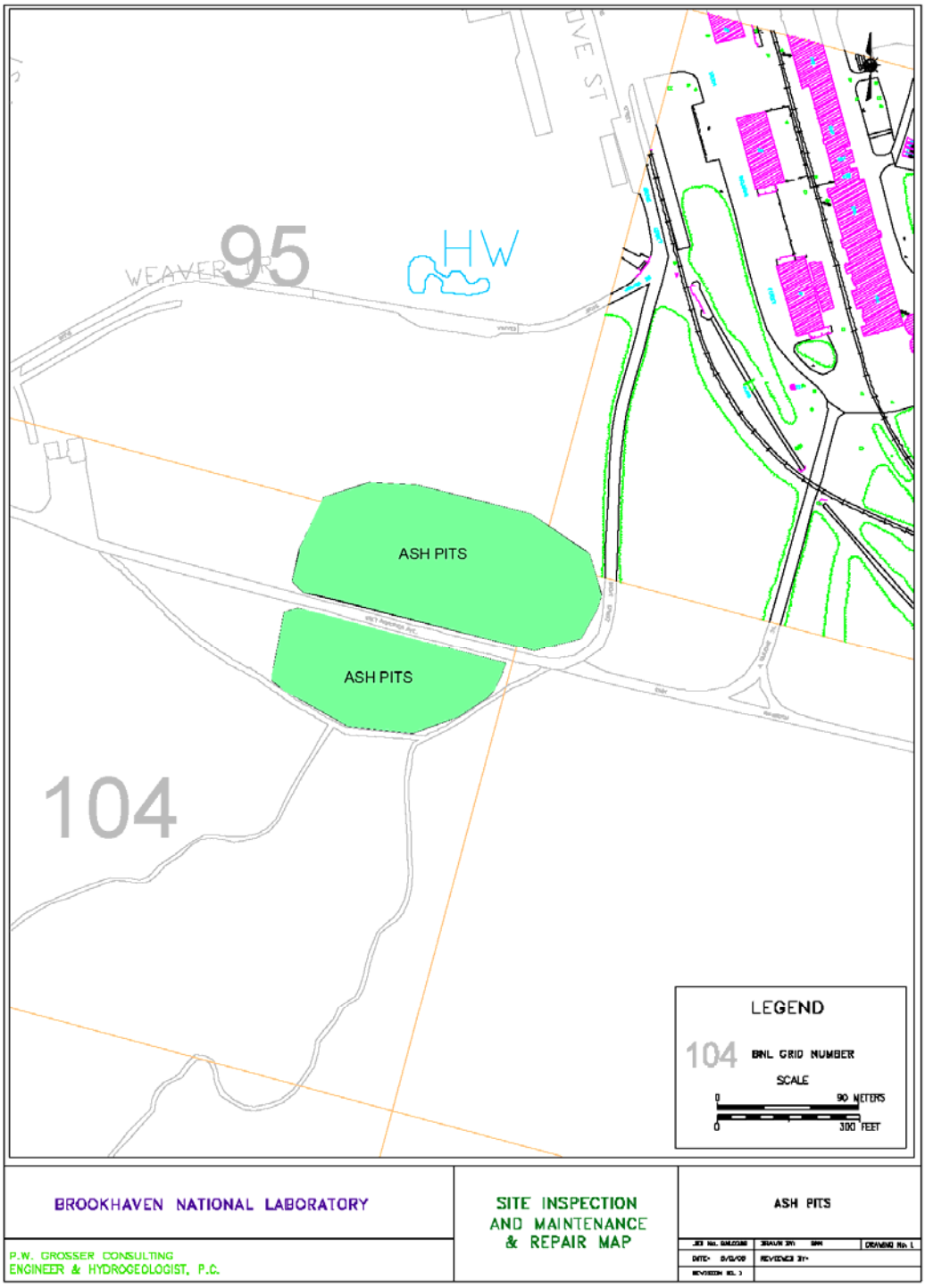
Former Hazardous Waste Management Facility (FHWMF)



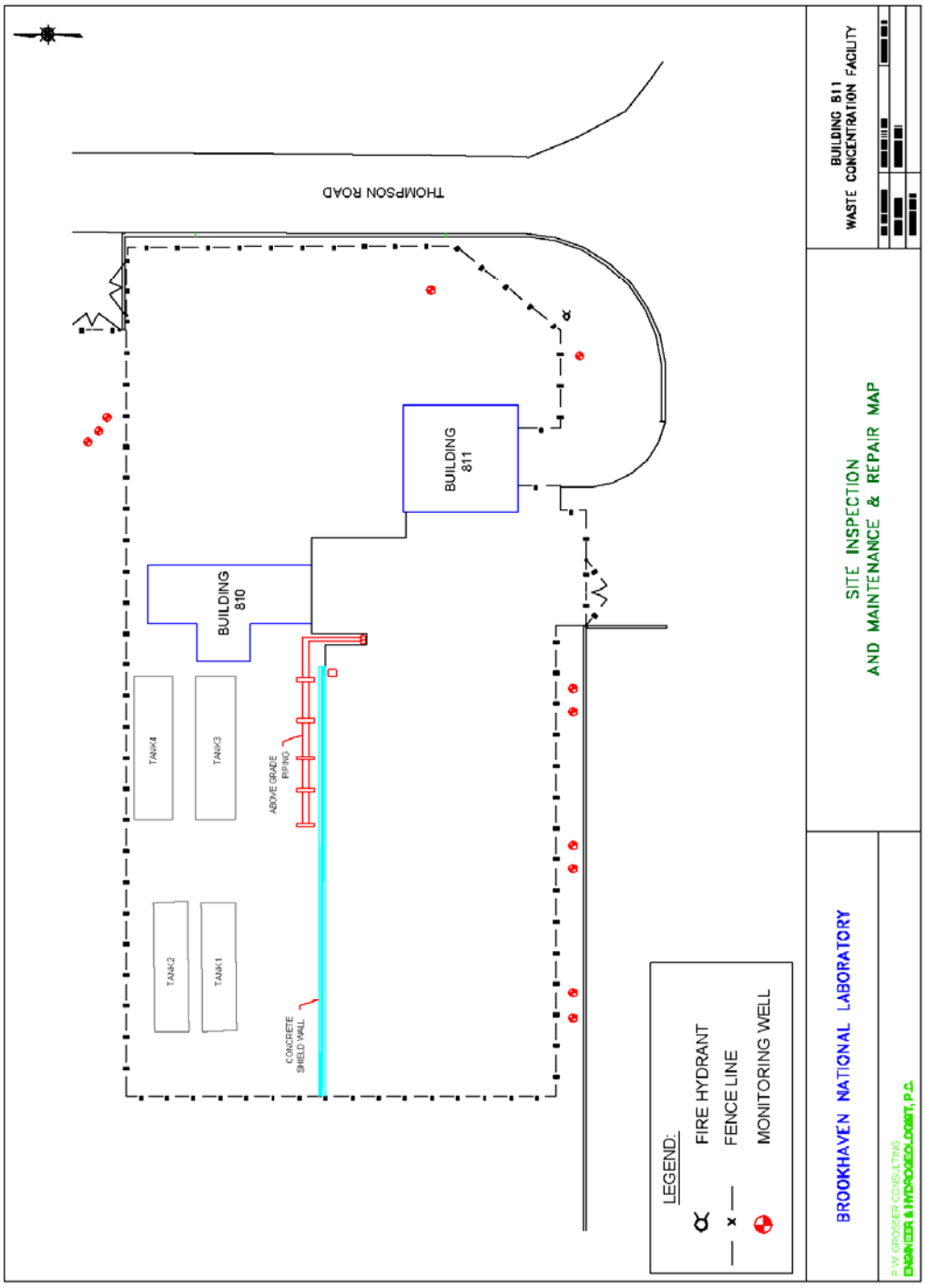
FHWMF Waste Loading Area



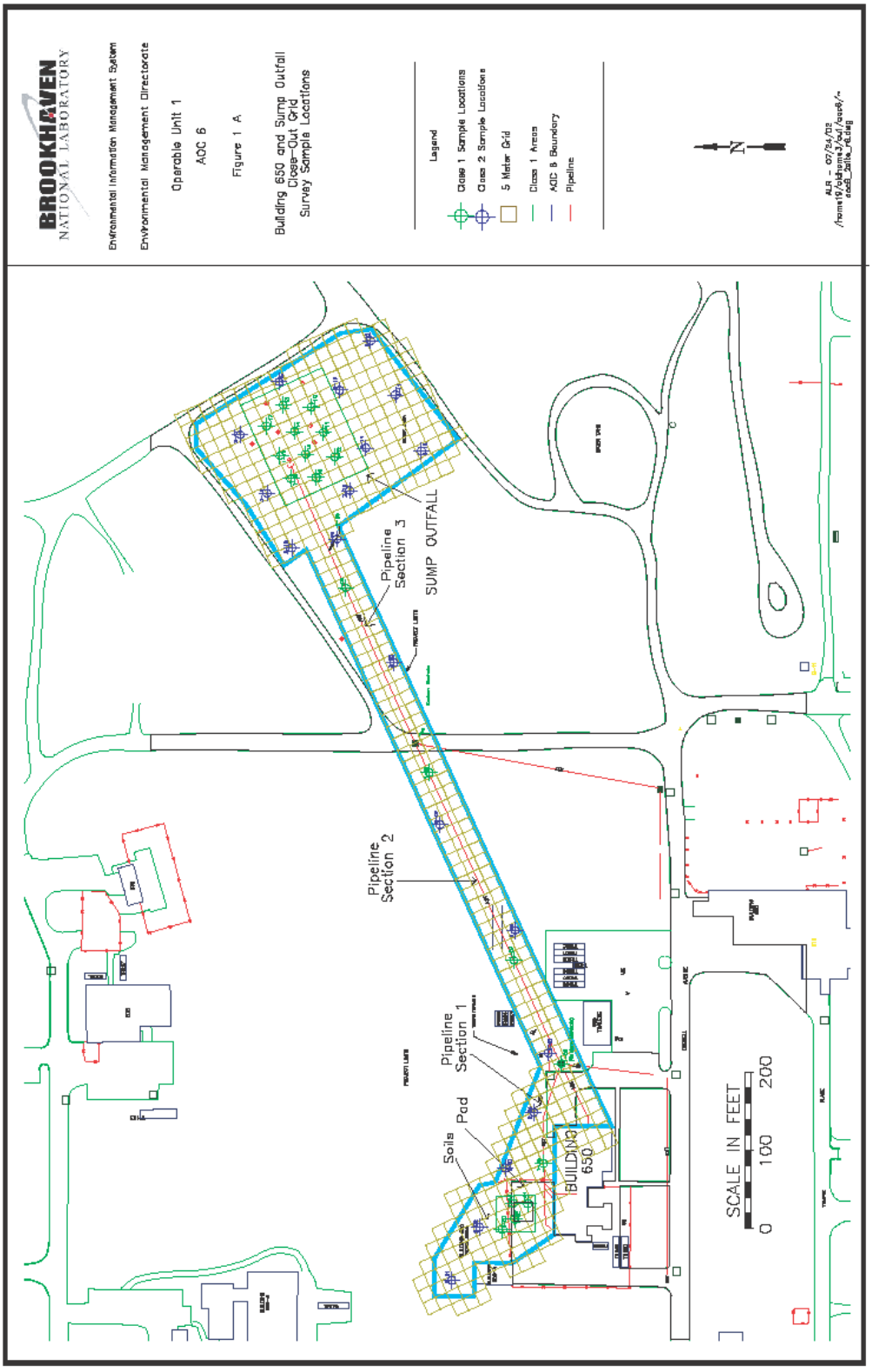
Ash Pit


95
HW
ASH PITS
ASH PITS
104
LEGEND
104 BNL GRID NUMBER
SCALE
0 90 METERS
0 300 FEET
BROOKHAVEN NATIONAL LABORATORY
P.W. GROSSER CONSULTING
ENGINEER & HYDROGEOLOGIST, P.C.
SITE INSPECTION
AND MAINTENANCE
& REPAIR MAP
ASH PITS

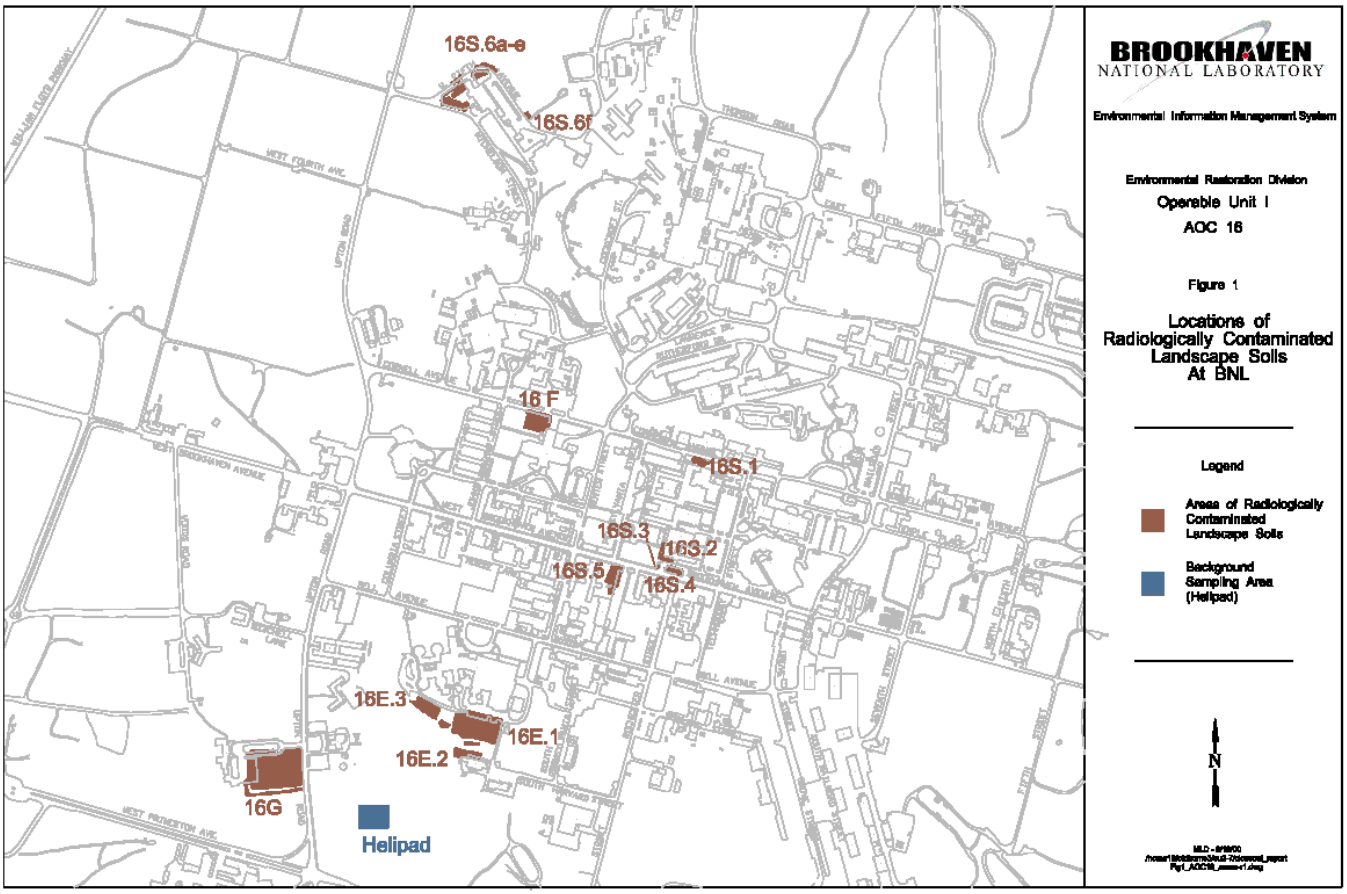
Building 811 Waste Concentration Facility



Building 650 Sump and Sump Outfall



Landscape Soils



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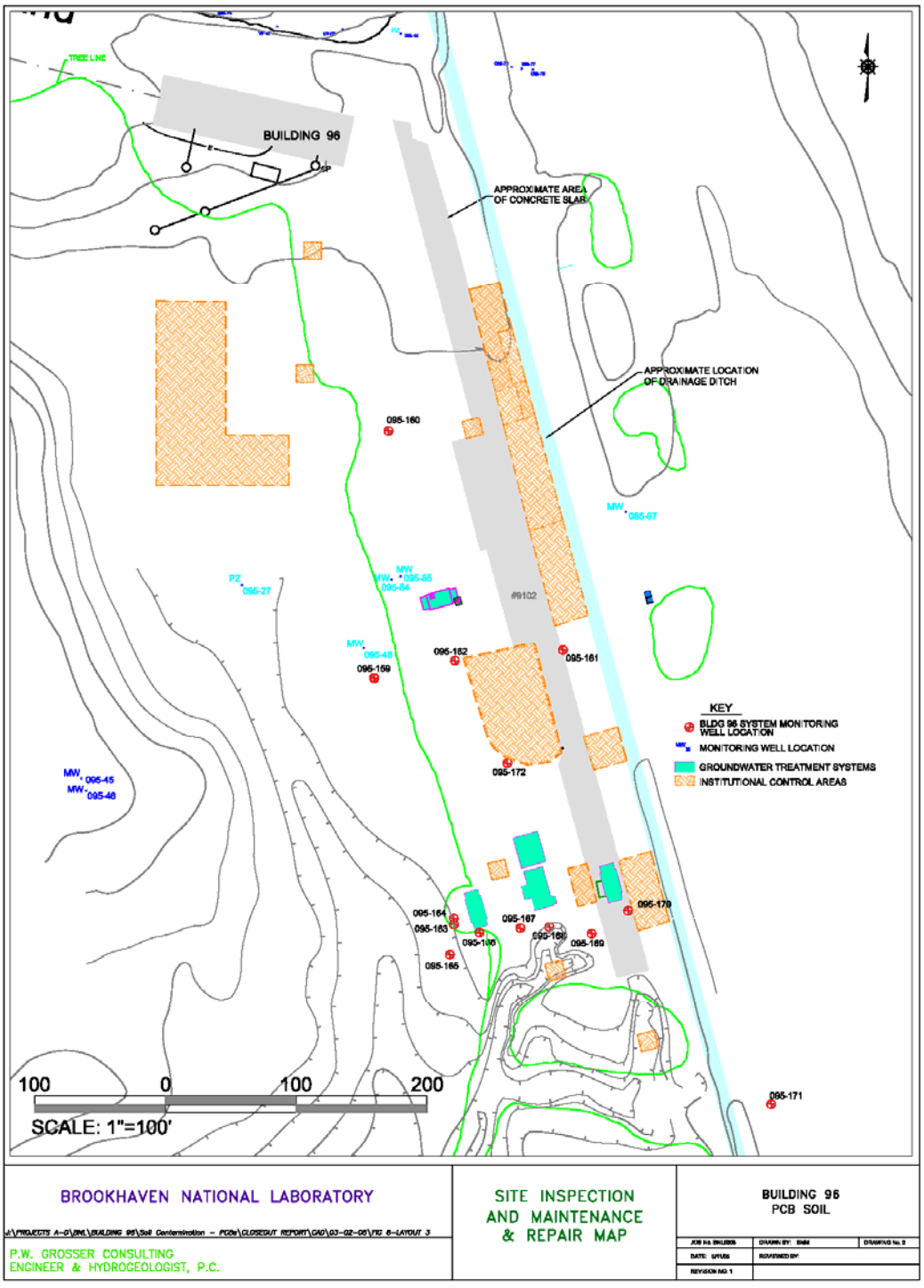
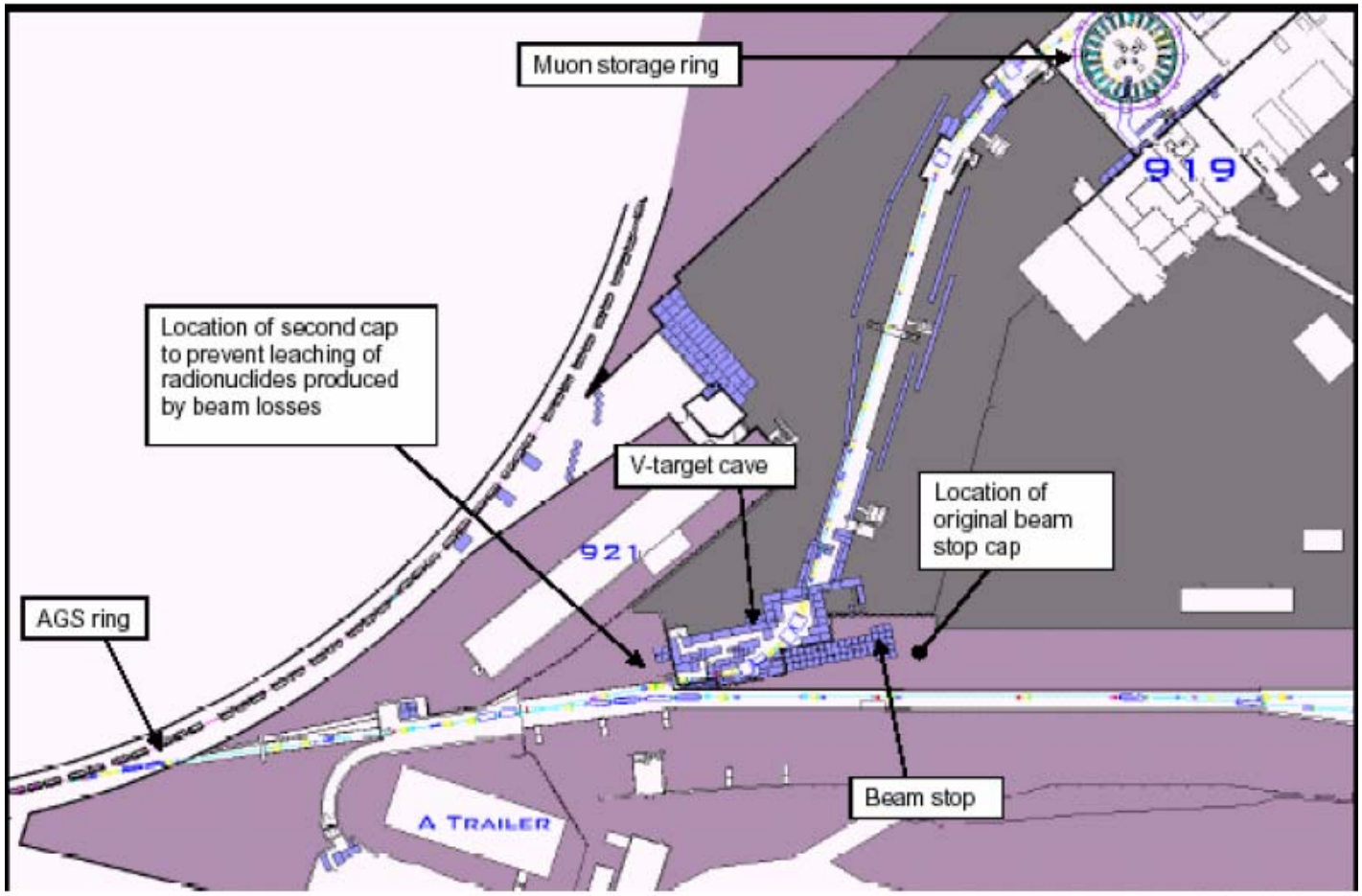
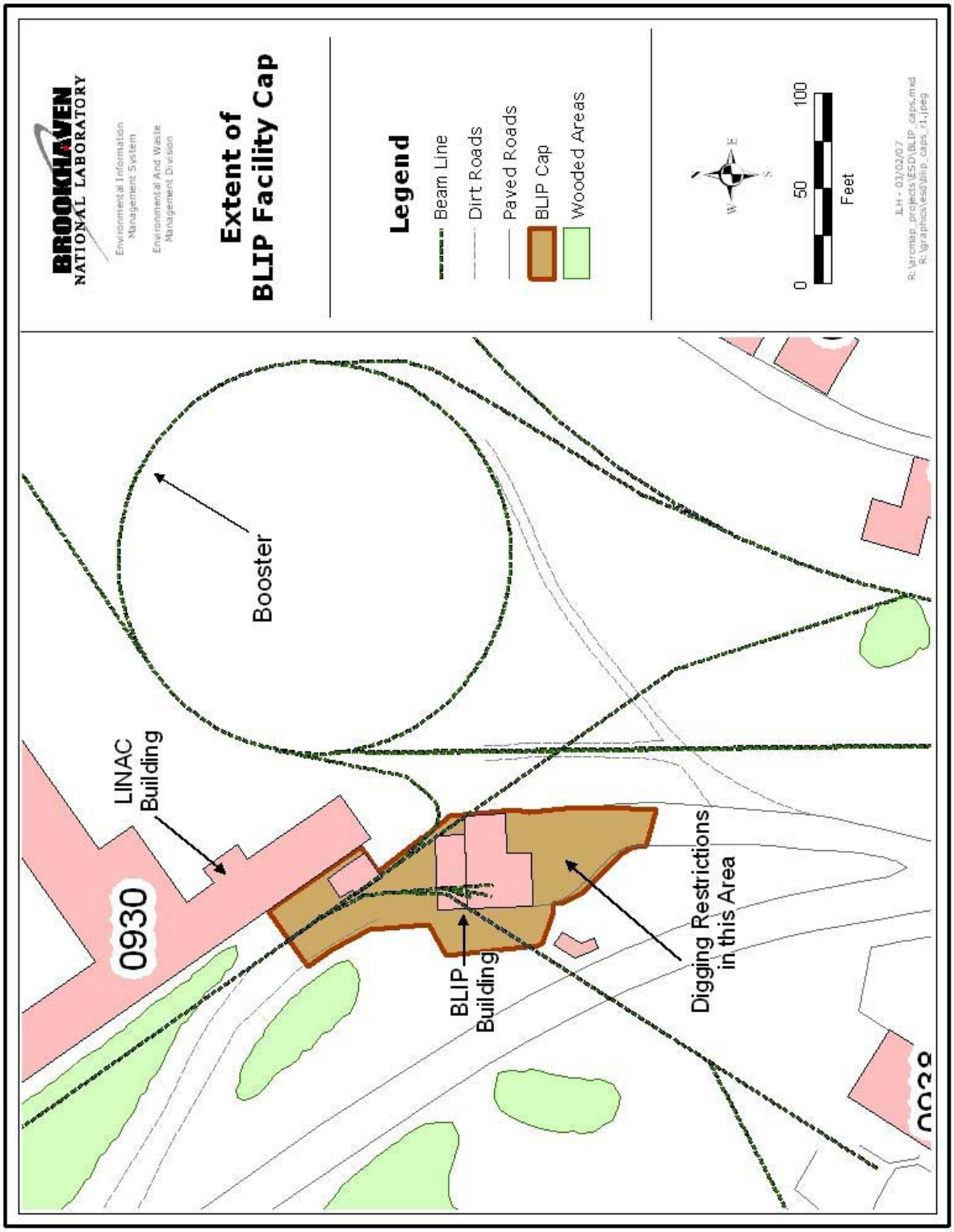


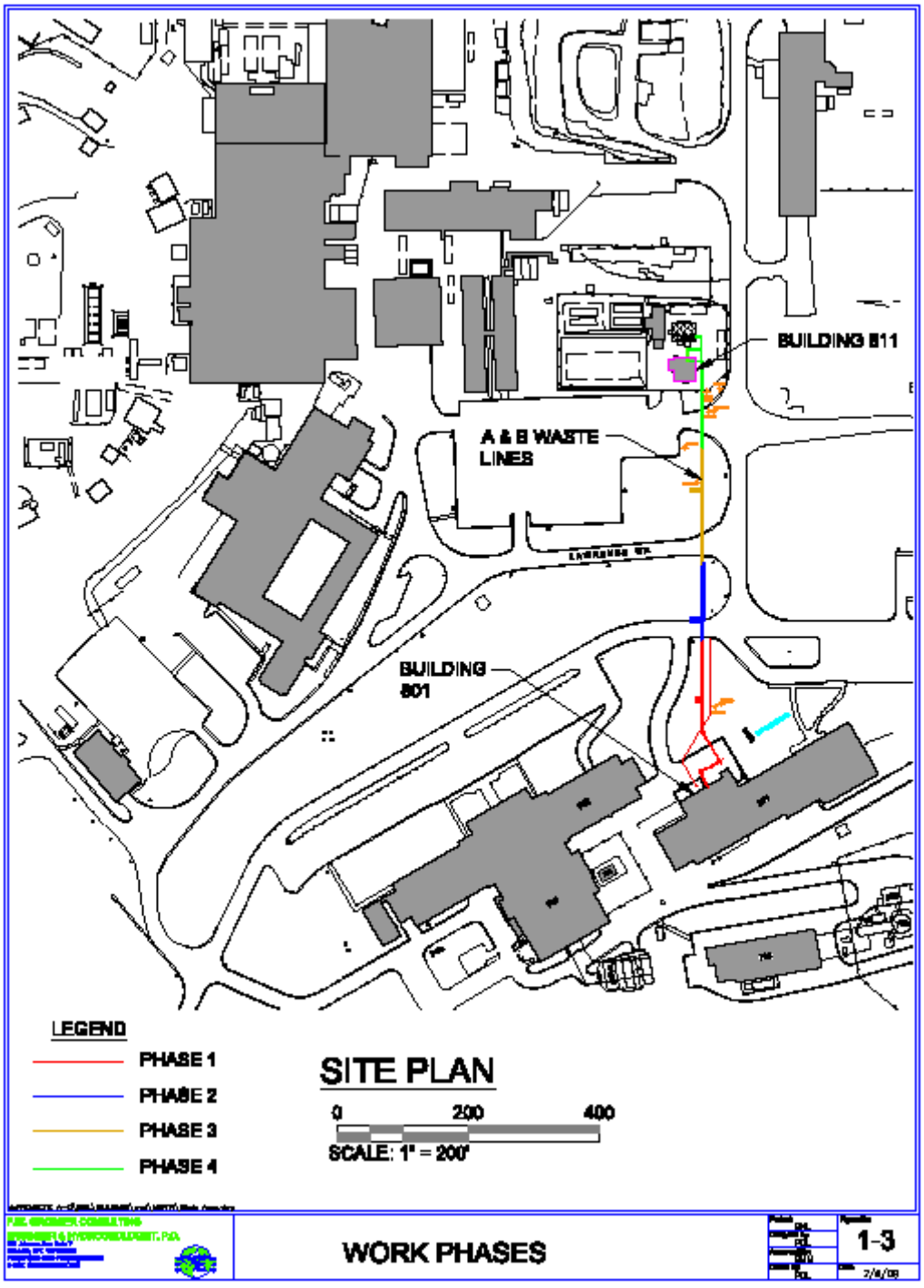
g-2 Source Area



BLIP Source Area



Waste Transfer Lines (A/B Waste Lines)



APPENDIX C

Peconic River Sampling and Analysis Plan

1.0 Introduction

This plan summarizes the sampling and analysis requirements for the Peconic River water column, sediment, and fish as required by the approved 2011 Five Year Review (BNL, 2011a and 2011b), the *Final Operable Unit V Record of Decision For Area of Concern 30 (Peconic River)* (DOE, 2004), described in the *Sampling Plan for Mercury and Methyl Mercury in the Water Column of the Peconic River* (QEA, 2003a), and the *2004 Peconic River Monitoring Downstream of Schultz Road, Sampling and Analysis Plan* (BNL, 2004). These reports and plans are referred to for additional details on sampling protocols and analysis. BSA has developed EM Standard Operating Procedures (SOPs) in accordance with these Plans.

As per the recommendation in the 2011 Five Year Review, modifications to the Peconic River fish monitoring program were initiated in 2012. The following table summarizes the Peconic River post-cleanup monitoring program samples collected starting in 2012.

Table C-1: 2012 Peconic River Post-Cleanup Monitoring Program

Medium	No. of Samples	Parameters	Method	Frequency
Surface water	15	Temperature, pH, dissolved oxygen, turbidity River water depth, flow Methylmercury Mercury TSS	Field measurements – "YSI" or equivalent EPA Method 1630 EPA Method 1631E EPA Method SM-20-2540D	Twice annually (June and August)
Sediment	3	Mercury PCBs Cesium-137	EPA Method 7471a EPA Method 8082 EPA Method 901.1	Annually (June)
Fish on BNL property	TBD 2 locations, top and bottom feeders	Temperature, pH, dissolved oxygen, turbidity, conductivity Mercury PCBs Cs-137 Length, weight Age	Field measurements – "YSI" or equivalent EPA Method 7471a EPA Method 8082 EPA Method 901.1 Aging of scales and otoliths	Every two years (spring)[1]
Fish off of BNL property	TBD 2 locations, top and bottom feeders	Temperature, pH, dissolved oxygen, turbidity, conductivity Mercury PCBs Cs-137 Length, weight, Age	Field measurements – "YSI" or equivalent EPA Method 7471a EPA Method 8082 EPA Method 901.1 Aging of scales/otoliths	Every two years (spring)

[1] The next fish collection is in 2013.

2.0 Peconic River Water Column Sampling

2.1 Program Objectives

The purpose of the water column sampling program is to monitor the distribution of total and methyl mercury concentrations in the Peconic River. The mercury and methylmercury data collected will be used to help locate sections of the river which may be contributing total mercury and methylmercury from the sediment to the water column and/or preferentially converting inorganic mercury to methylmercury. This will help to ensure that no potential significant impacts to human health and the environment remain. Nearly all of the mercury found in higher trophic level invertebrates and fish is methylmercury and, thus, it is important to understand methylmercury levels in the water column of the river.

2.2 Sampling Locations

The sampling program was designed to collect information that will help to achieve the objectives outlined in Section 2.1 above. As per the recommendation in the 2011 Five Year Review, modifications to the Peconic River surface water monitoring program were initiated in 2012. The stations are listed in Table C-2 below and shown on Figure C-1.

Water column samples are obtained in June and July at 15 routine stations (provided sufficient water is present) along the Peconic River between PR-WC-15 (upstream of the BNL STP) and PR-WC-02. The sample locations are listed in the following table:

Table C-2: 2012 Peconic River Post-Cleanup Water Column Monitoring Program

Station	Description	Distance Downstream of STP (miles)
PR-WC-15	Upstream of STP	-0.17
PR-WC-14	Upstream of STP	-0.13
PR-WC-13	Upstream of STP	-0.07
PR-WC-12D7	Upstream of STP	-0.04
STP-EFF-UVG	STP Outfall	0.0
PR-WC-11D7	West of HMn	0.01
PR-WC-10	West of HMn	0.3
PR-WC-09	Downstream of HMn	0.56
PR-WC-08	South of Area B	0.78
PR-WC-07	South of Area C	0.96
PR-WC-06	North of Area D	1.10
PR-WC-05	Downstream of HQ	1.46
PR-WC-04	2nd Downstream of HQ	1.70
PR-WC-03	3rd West of Schultz Road	2.10
PR-WC-02	2nd West of Schultz Road	2.52

2.3 Sampling Protocol and Analysis

There are two water column sampling events each year: one event in June, and one event in July when the methylation of mercury in the sediments is likely to be greatest. Water column samples are collected at one half the total water depth in the middle of the channel at each location using appropriate sampling techniques. Samples are taken at all locations provided water depths are at least 12 inches. The total water depth and river velocity at each sampling location is measured and recorded in the field log. The actual sample collection at each station will be of sufficient depth to avoid suspending sediment with the sampling equipment. Samples are collected in accordance with EPA Method 1669 for sampling trace metals that is summarized in BNL EM SOP 405. Additional guidance is described in EPA Method 1630 for methylmercury and EPA Method 1631 for total mercury analysis. Analytical data is provided as an EPA standard summary data package style. A summary of the sampling collection, preservation, and analytical requirements are provided in Table C-3.

Table C-3: Water Column Sample Collection, Preservation and Storage

Frequency	Twice annually – June and July
Sample container	Mercury, methylmercury and TSS samples will be collected in a pre-cleaned 2 L fluorinated high density polyethylene (FLPE) sample jar provided by the analytical lab with an FLPE-lined cap.
Analyses, Sample Volume*	Methyl Mercury – EPA Method 1630, 500 ml Mercury – EPA Method 1631, 500 ml Total Suspended Solids – EPA Method 160.2, 1000 ml
Preservation	Field preservation – Store and ship at not greater than 4^{o}C. Ship to lab on collection day via overnight delivery. On receipt: the analytical lab will subdivide and preserve the aliquots for mercury analysis (500 ml, 1% BrCl), methylmercury (500 ml, 0.4% HCl) and TSS (1 L, store at 4^{o} C for analysis within 7 days).
Turnaround time	30 days
Shipment	Day of collection, Contact analytical lab prior to shipping

* Mercury, methylmercury and TSS sample volume will be collected in the same 2 L container.

3.0 Peconic River Sediment Sampling Program

3.1 Program Objectives

The purpose of the post-cleanup sediment sampling program is to monitor the long-term effectiveness of the remedial actions (i.e., removal and disposal of Peconic River sediments above cleanup goals for mercury), and to ensure that no significant impacts to human health and the environment remain.

3.2 Sediment Sampling Locations

The sampling program was designed to collect information that will help to achieve the objectives for the sediment sampling, as outlined in Section 3.1 above. As per the recommendation in the 2011 Five Year Review, modifications to the Peconic River sediment monitoring program were initiated in 2012. The Peconic River is an intermittent stream (i.e., fully flowing during portions of the year and partially dry during other times) and sediment samples are now collected from three locations in normally "wet" areas of the Peconic River regardless of the presence of water at the time of sampling. The locations are from the three areas where supplemental sediment removal took place in 2010/2011. The samples are biased to the maximum pre-cleanup mercury concentration at each location. The sampling locations are indicated on Figure C-2, and are as follows:

- One samples from sediment located at Area D (PR-WC-06-D1-L50)
- One sample from sediment located at Area D at the former sediment trap (ST1-80-U20)
- One sample from sediment located at Area D downstream of the former sediment trap (PR-SS-15-U1-L65-O)

3.3 Sampling Protocol and Analysis

Sediment samples of the top six inches of sediment are collected using sediment sampling tools and techniques (EM SOP-600) employed by the BSA field crew. Use of a coring device facilitates the separation of the overlying fine grained sediment form the underlying sand layer. Peconic River contaminants are typically more contaminated in the fine-grained sediment than in the underlying sand. Upon retrieval, each sediment sample is visually inspected and the sample coordinates and total depth of sediment recovered is recorded in the field log. The top six-inches, or that portion which represents sediment, of the sample is placed in a sample container that is labeled with a sample identification number that is unique to each sampling location and sample depth increment (to be developed by the BNL field crew) and placed on ice. Additional sampling may be required from the same location to achieve the proper sample volume. A brief description of the physical characteristics of each sample is recorded in the field log. These characteristics include general soil type (e.g., sand, silt, clay, organic/other matter), approximate grain size (e.g., fine, medium, coarse), and color. Also, the total water depth at each sampling location is measured and recorded in the field log. Analytical data is provided as an EPA standard summary data package. A summary of the sampling collection, preservation, and analytical requirements are provided in Table C-5.

Table C-5: Sediment Sample Collection, Preservation and Storage	
Frequency	Once annually – June
Sample container	Glass
Analyses/volume	Mercury – EPA Method 7471a – 4 ounce PCBs – EPA Method 8082 – 4 ounce Cs-137 – EPA Method 901.1 – 4 ounce
Preservation	Store and ship at not greater than 4 ^{o}C
Turnaround time	30 days

* Sample volume varies with between analytical laboratories. Check with laboratory prior to sampling event.

4.0 Peconic River Fish Sampling Program

4.1 Program Objectives

The purpose of the fish sampling program is to monitor the long-term effectiveness of the remedial action (i.e., removal and disposal of Peconic River sediments above cleanup goals for mercury, PCBs, and Cs-137) and to ensure that no potential significant impacts to human health and the environment remain. The Data Quality Objectives support the use of the fish for comparison between the analytical results of fish collected before and after the cleanup. As per the recommendation in the 2011 Five Year Review, modifications to the Peconic River fish monitoring program were initiated in 2012. Four Peconic River fish sample locations have been selected to include stations that: 1) are accessible for potential fishing, 2) maximize the potential that the station would have sufficient water to support fish, and 3) are in close proximity to surface water and sediment sampling locations. The first three of the four locations are in sections of the Peconic River that were remediated in 2004 and 2005, and in 2010/2011 at three locations.

In addition to the Peconic River collections mentioned, additional fish are also be collected by the Lab's Surveillance Monitoring Program at Lower Yaphank Lake. Due to long-term data sets showing little or no influence from the Laboratory, sampling at Swan Pond and Forge Pond will be discontinued beginning in 2013. Based on the Five-Year Review of the Peconic River cleanup program, fish sampling between post-cleanup monitoring and the Surveillance Monitoring Program will be alternated. Post-cleanup monitoring will occur in odd numbered years (next in 2013) and surveillance monitoring will occur in even numbered years (next in 2014), until such time as the Laboratory no longer discharges the STP effluent to the Peconic River.

Between five to ten fish for each of two species are collected at each area. Focus is made to include a top carnivore, e.g. largemouth bass or chain pickerel, and a bottom feeder, e.g. white sucker or brown bullhead. When fish from these two species and/or trophic levels are not available, substitutions are made based on availability and size. All fish samples consist of only edible tissue that was removed from the fish (filleted) by the BSA field team. Because the proportion of edible fish tissue to total body weight is highly variable depending on fish size and other factors, the filleted tissue from two or more fish may need to be composited together to obtain sufficient sample mass to obtain mercury, PCB and radionuclide analyses across the size range of Peconic River fish.

4.2 Fish Sampling Locations

Fish samples are collected from four sections (Table C-6) of the Peconic River to address Peconic River ROD-required fish sampling. It should be noted that the discharge from the BNL STP will be redirected to groundwater recharge in 2014. This may impact fish collection in certain areas since sufficient water may not be available to support fish. To the extent that water level allows, and fish abundance and size allow, fish will be collected from the following sections of the river:

Table C-6. 2012 Peconic River Fish Collection Locations	
Remediation Area	Location Description
Area A	Between stream gauging stations HE and HMn
Area D	Along North Street in the ponded sections of the river upstream and downstream of stream gauging station HQ. If water level or fish population size is not sufficient for fish collection, the ponded section of the river in remediation Area C may be substituted.
Area P	Upstream of Schultz Road.
Donahue's Pond	Donahue's Pond is an impounded section of the Peconic River at the Peconic River Sportsman's Club. Donahue's Pond is approximately 2 miles downstream of the Manor Road cleanup area.

As with any field program, field conditions at the time of sampling may preclude collection of fish at numbers specified in sampling plans. Reasonable attempts are made to achieve needed numbers of fish to meet objectives. If fish are unavailable from Area D, then the substitute location, Area C, may be used to meet the stated objectives.

4.3 Sampling Protocol and Analysis

Fish samples are analyzed for total mercury, PCBs (on Laboratory property only) and Cs-137. Scales and otoliths (for brown bullhead) are also collected to determine the age of the fish. All analytical values are reported as concentration or activity per unit wet weight of fish tissue. Fish are collected following BNL EM-SOP-701. Analytical data is provided as an EPA standard summary data package. A summary of the sampling collection, preservation, and analytical requirements are provided in Table C-7.

Table C-7: Fish Sample Collection, Preservation and Storage	
Frequency	Every two years in the spring–(next collection is in 2013)
Sample container	Plastic (polyethylene) bags
Analyses*/volume	Mercury – EPA Method 7471a – 4 ounce PCBs – EPA Method 8082 – 4 ounce Gamma spectroscopy – EPA Method 901.1 – 4 ounce
Preservation	Store and ship at not greater than 4 ^{o}C
Turn-around time	30 days

* Sample volume varies with between analytical laboratories. Check with laboratory prior to sampling event.

5.0 Quality Control

The overall QA objective for environmental sampling and analysis at BNL is to generate data that is of known quality and in compliance with specified DQOs. This section discusses the specific quality control samples and documentation necessary to meet the DQOs. The DQOs for this project can be found in the BNL EMP.

5.1 Type and Frequency of Field Quality Control Samples

The type, frequency and rationale for selection of specific field QC samples varies by environmental matrix and minimum requirements for use are provided in, *EM-SOP-200, Collection and Frequency of Field Quality Control Samples* and EPA Methods 1630, 1631and 1669. Surface water samples are collected at the rate of ten percent, which is one QA/QC sample per ten collected samples. Sediment and fish sample are collected at the rate of five percent. Details are discussed below and are summarized in Table C-8.

Field blanks will be collected to evaluate potential cross-contamination of samples caused by the sampling environment and procedures. They are required to demonstrate that the contamination of the water samples has not occurred during the field sampling process. Peconic River field blanks will be collected only for the surface water collections. The frequency of field blanks to be collected is one field blank for every twenty surface water samples shipped to the analytical laboratory or one per sampling round, whichever is more frequent.

Field blanks will be generated in the field by collecting a water sample from a container that was filled with reagent water provided by the analytical laboratory in the laboratory and transported to the sampling site. Using the same “clean hands” - “dirty hands” techniques used to collect the surface water samples, two liters of reagent water will be transferred to a 2 L sample container, treated in the same manner as the environmental samples, and sent to the contracted laboratory for analysis. If the results indicate that contamination is present in the source sampled, the associated samples may be considered biased and the data will be qualified according to USEPA Region II data validation rules.

Blind duplicate samples will be analyzed to check laboratory reproducibility of the analytical data. At least five percent (one out of every 20 samples) of the total number of surface water and sediment samples collected will be duplicated to evaluate the precision of the methods used. The field sampling team will complete a supplemental form to identify blind duplicates. The form shall not be forwarded to the analytical laboratory.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples are required to evaluate the precision and accuracy of the laboratory method. MS/MSDs will be collected and analyzed at the rate of five percent for surface water, sediment, and fish samples. An aliquot of the sample is spiked with a known quantity of the analyte by the laboratory and analyzed with the samples. If the percent recovery of the analyte is deemed to be low, based on USEPA Region II data validation guidelines, the matrix of the sample is assumed to be interfering with the analysis and the analytical results will be qualified.

Laboratory Duplicate (LD) will be collected for the surface water, sediment and fish sampling program at the rate of five percent. If the relative percent difference of the analyte is deemed to be outside QA limits, based on USEPA Region II data validation guidelines, the analytical results will be considered biased and the data will be qualified.

Equipment blank samples are sometimes collected to verify that the effectiveness of the decontamination process for non-dedicated or reusable sampling equipment. Equipment blanks will be collected for the sediment and fish sampling programs, at the rate of five percent. Equipment rinsates are collected from the final rinse water generated using a laboratory-grade water source. If the results indicate that contamination is present in the source sampled, the associated samples may be considered biased and the data will be qualified according to USEPA Region II data validation rules.

Table C-8: Peconic River Quality Control Samples

	Field blanks	Blind Duplicate samples	Matrix Spike/Matrix Spike Duplicates	Laboratory Duplicates	Equipment Blanks	TOTAL
Surface Water	1	1	1	1	-	4
Sediment	-	1	1	1	1	4
Fish	-	-	1	1	1	3

5.2 Instrument Calibration

EM-SOP-101, *Measuring Water Quality and Test Equipment using an YSI Instrument*, will be followed by all field personnel collecting water samples. If for any reason it becomes necessary to obtain water quality parameters using an instrument other than the YSI, the manufacturer's instruction manual will be followed. The field sampling team shall log the instrument used on the field Groundwater Sampling Log Form.

5.3 Field Documentation

Documentation of field activities is covered by EM-SOP-201. All field sampling technicians (BNL employed and contractor), staff hydrogeologists, and environmental scientists shall be responsible for documenting field activities in a bound waterproof field logbook and required forms or logs as outlined in this procedure. Copies of all records generated as a result of this procedure are to be maintained in the appropriate project files in accordance with the ESH&Q Directorate Records Management Procedure (DH-ADM-002) requirements. The appropriate Work Control Coordinator shall maintain completed copies of the Work Permits. Chain-of-custody documentation will follow the procedures detailed in EM-SOP-109.

6.0 References

BNL, 2004. *2004 Peconic River Monitoring Downstream of Schultz Road, Sampling and Analysis Plan*, Brookhaven National Laboratory, Upton, New York, February 13, 2004.

Quantitative Environmental Analysis, LLC, 2003a. *Sampling Plan for Mercury and Methyl Mercury in the Water Column of the Peconic River*, Brookhaven National Laboratory, Upton, New York, April 23, 2003.

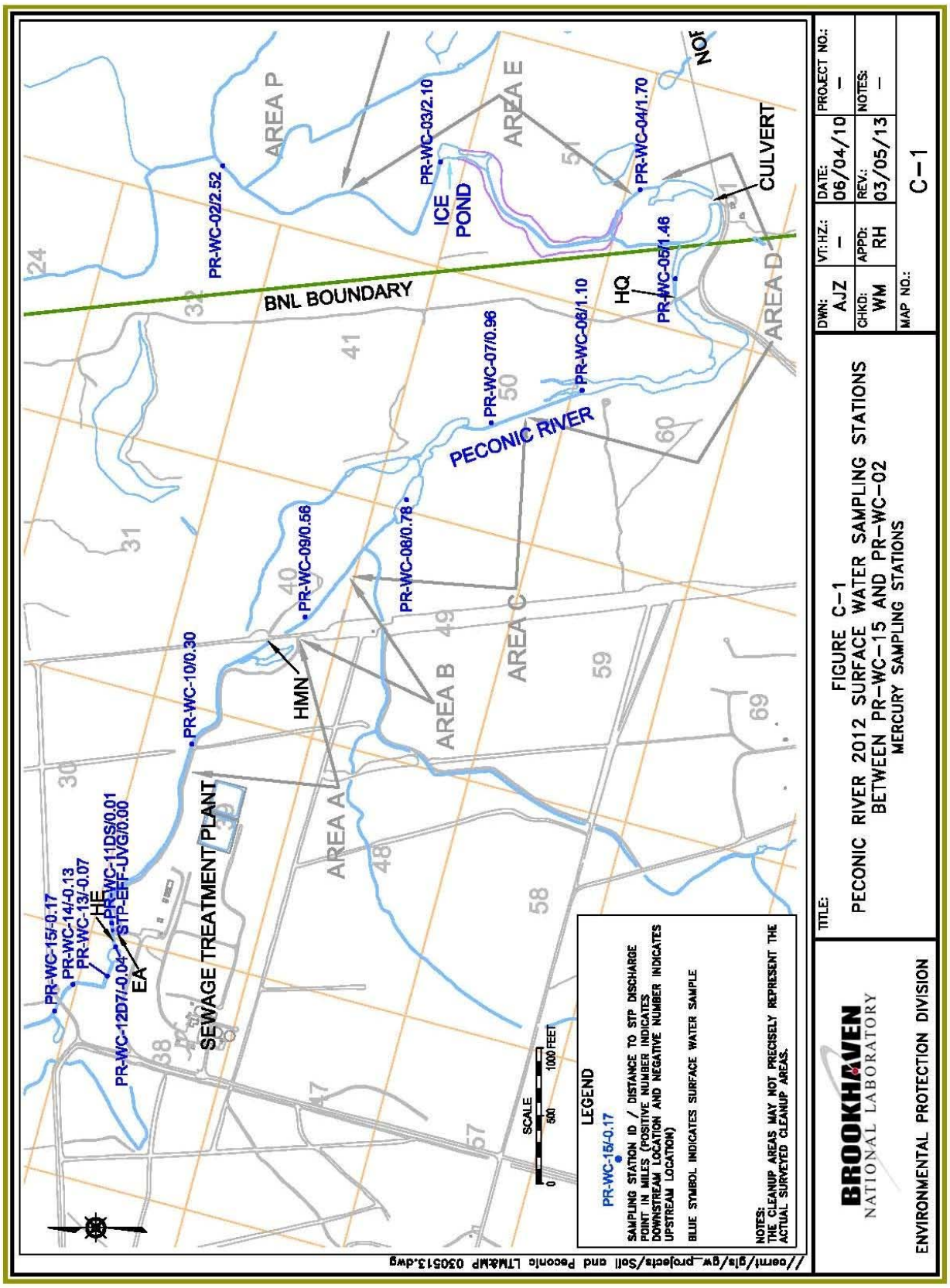
Quantitative Environmental Analysis, LLC, 2004. *Peconic River 2003 Data Summary Report*, Brookhaven National Laboratory, Upton, New York, March 2004.

USEPA 1996. Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels, EPA 821-R-96-011, and July 1996.

USEPA 2001. Method 1630: Methyl Mercury in Water by Distillation, Aqueous Ethylation, Purge and Trap, and CVAFS, EPA 821-R-01-020, January 2001 - 1630.pdf (495KB)

USEPA, 2002. Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry, **EPA 821/R-02-019,** August 2002. (http://www.epa.gov/waterscience/methods/1631.html)

Figure C-1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PR-WC-11DS/0.01
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STP-EFF-UVG/0.00
EA
SEWAGE TREATMENT PLANT
PR-WC-10/0.30
HMN
PR-WC-09/0.56
PR-WC-08/0.78
PR-WC-07/0.96
PR-WC-08/1.10
PR-WC-05/1.46
HQ
PR-WC-04/1.70
PR-WC-03/2.10
PR-WC-02/2.52
ICE POND
CULVERT
NOF
BNL BOUNDARY
PECONIC RIVER
AREA A
AREA B
AREA C
AREA D
AREA E
AREA P
SCALE
0
500
1000 FEET
LEGEND
PR-WC-15/-0.17
SAMPLING STATION ID / DISTANCE TO STP DISCHARGE POINT IN MILES (POSITIVE NUMBER INDICATES DOWNSTREAM LOCATION AND NEGATIVE NUMBER INDICATES UPSTREAM LOCATION)
BLUE SYMBOL INDICATES SURFACE WATER SAMPLE
NOTES:
THE CLEANUP AREAS MAY NOT PRECISELY REPRESENT THE ACTUAL SURVEYED CLEANUP AREAS.
//oerrt/gis/gw_projects/Soil and Peconic LTM.mp 030513.dwg
BROOKHAVEN
NATIONAL LABORATORY
ENVIRONMENTAL PROTECTION DIVISION
TITLE:
FIGURE C-1
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BETWEEN PR-WC-15 AND PR-WC-02
MERCURY SAMPLING STATIONS
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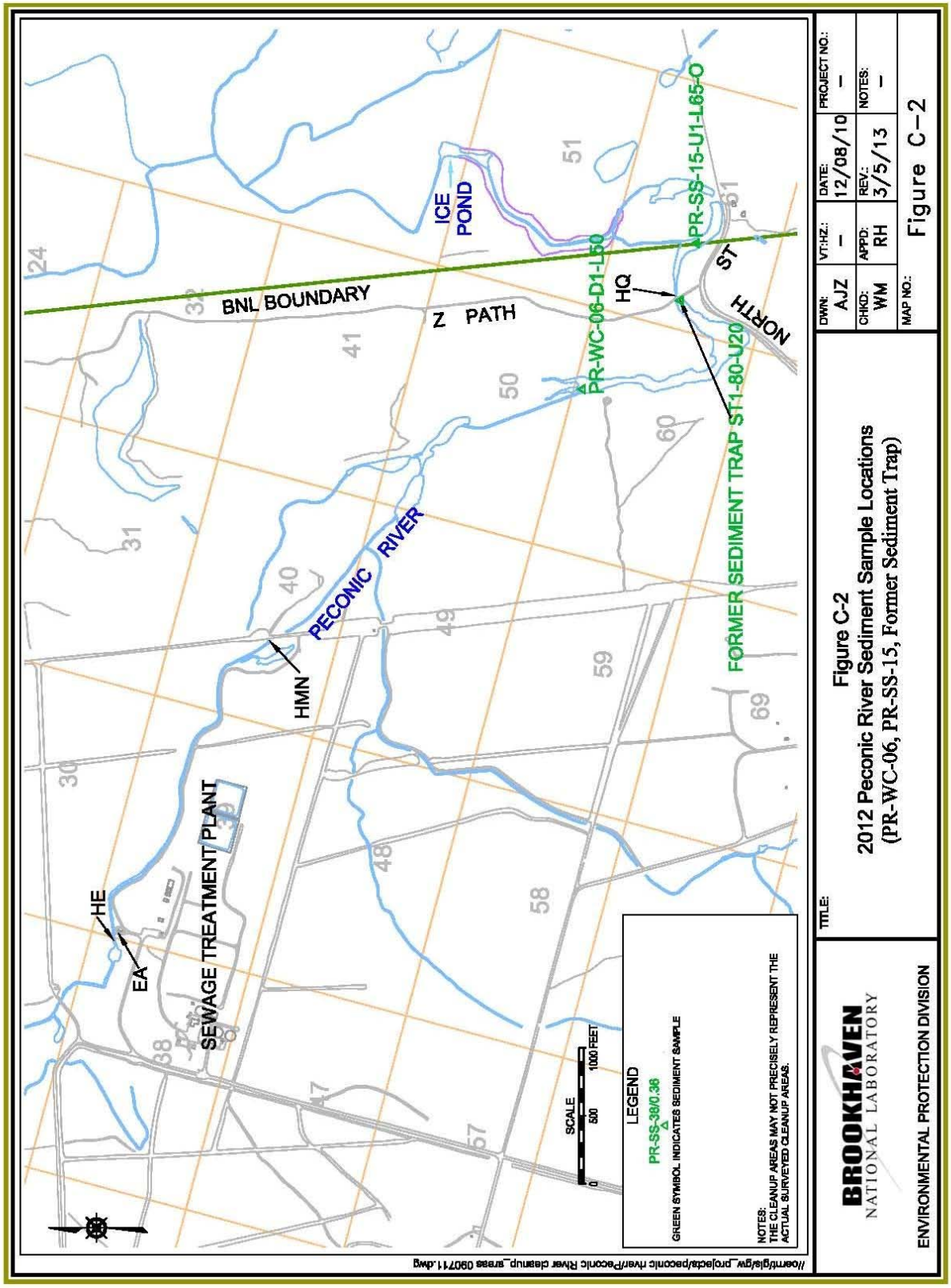
VT: HZ.: –
DATE: 06/04/10
PROJECT NO.: –
CHKD: WM
APPD: RH
REV.: 03/05/13
NOTES: –
MAP NO.: C-1

Figure C-2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ICE POND
PECONIC RIVER
HMN
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EA
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PR-WC-06-D1-L50
PR-SS-15-U1-L65-O
HQ
ST
NORTH
FORMER SEDIMENT TRAP ST1-80-U20
LEGEND
PR-SS-38/0.36
GREEN SYMBOL INDICATES SEDIMENT SAMPLE
SCALE
0
500
1000 FEET
NOTES:
THE CLEANUP AREAS MAY NOT PRECISELY REPRESENT THE ACTUAL SURVEYED CLEANUP AREAS.
//oerrdfs/gw_projects/peconic river/Peconic River cleanup_areas 090711.dwg
BROOKHAVEN NATIONAL LABORATORY
ENVIRONMENTAL PROTECTION DIVISION
TITLE:
Figure C-2
2012 Peconic River Sediment Sample Locations
(PR-WC-06, PR-SS-15, Former Sediment Trap)
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CHKD: WM
VT:HZ.: –
APPD: RH
DATE: 12/08/10
REV.: 3/5/13
PROJECT NO.: –
NOTES: –
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