REMEDIAL INVESTIGATION AND FEASIBILITY STUDY WORK PLAN (FINAL)

BENNING ROAD FACILITY

3400 BENNING ROAD, N.E.

WASHINGTON, DC 20019

PREPARED FOR:

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pepco

A PHI Company

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Washington, DC 20019

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List of Acronyms

ANS	Academy of Natural Sciences
ASTM	American Society for Testing and Materials
AST	Aboveground Storage Tank
AVS	Acid Volatile Sulfide
AWTA	Anacostia Watershed Toxics Alliance
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIP	Community Involvement Plan
cm/yr	Centimeter per Year
COC	Constituent of Concern
CLP	Contract Laboratory Program
COPC	Constituent of Potential Concern
CSF	Complete Sample Delivery Group File
CSM	Conceptual Site Model
CSO	Combined Sewer Overflow
DC	District of Columbia
DCRA	Department of Consumer and Regulatory Affairs
DCWASA	District of Columbia Water and Sewer Authority
DDOE	District Department of the Environment
DGPS	Differential GPS
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DOD	Department of Defense
DQO	Data Quality Objectives
DPT	Direct Push Technolgy
EDD	Electronic Data Deliverables
EDR	Environmental Data Resources
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ERI	Electrical Resistivity Imaging
ESA	Environmental Site Assessment
ESTCP	Environmental Security Technology Certification Program
FS	Feasibility Study
FSP	Field Sampling Plan
ft bgs	Feet Below Ground Surface
GC/MS	Gas Chromatography/Mass Spectrometry
GIS	Geographic Information System
GPS	Global Positioning System
GSA	General Services Administration
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
HSA	Hollow Stem Auger
ICP	Inductively Coupled Plasma
ICPMS	Inductively Coupled Plasma-Mass Spectrometry
IDW	Investigation Derived Waste

KPN	Kenilworth Park North
KPS	Kenilworth Park South
LNAPL	Light Non-Aqueous Phase Liquid
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
MLLW	Mean Low Low Water
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MW	Megawatt
MWCOG	Metropolitan Washington Council of Governments
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priority List
NPS	National Park Service
NPDES	National Pollutant Discharge Elimination System
NRDA	Natural Resource Damage Assessment
NTU	Nephelometric Turbidity Units
NWP	Nationwide Permit
OSWER	U.S. EPA Office of Solid Waste and Emergency Response
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PES	Pepco Energy Services
PID	Photoionization Detector
PPE	Personal Protective Equipment
ppm	Parts per Million
PRG	Preliminary Remediation Goal
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/ Quality Control
RAO	Remedial Action Objectives
RAS	Routine Analytical Services
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasbility Study
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SDG	Sample Data Group
SEM	Simultaneously Extractable Metals
SEFC	Southeast Federal Center
SI	Site Inspection
SOP	Standard Operating Procedure
SOW	Scope of Work
SPT	Standard Penetration Test
SQG	Sediment Quality Guidelines
SVOC	Semi-Volatile Organic Compound
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TRV	Toxicity Reference Values
TSCA	Toxic Substances Control Act
µg/kg	Microgram per Kilogram
µmhos/cm	Micromhos per Centimeter

USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WGL	Washington Gas Light
WMATA	Washington Metropolitan Area Transit Authority
WNY	Washington Navy Yard
XRF	X-Ray Fluorescence

1 Introduction

AECOM has prepared this Remedial Investigation and Feasibility Study (RI/FS) Work Plan on behalf of Potomac Electric Power Company (Pepco) and Pepco Energy Services, Inc. (collectively "Pepco") to describe the overall technical approach of the RI/FS at Pepco's Benning Road facility (the Site), located at 3400 Benning Road NE, Washington, DC, and a segment of the Anacostia River (the River) adjacent to the Site. The general site location is shown on **Figure 1**. Together, the Site and the adjacent segment of the River are referred to herein as the "Study Area". Pepco has agreed to perform the RI/FS pursuant to a consent decree that was entered by the U.S. District Court for the District of Columbia on December 1, 2011 (the Consent Decree). The Consent Decree documents an agreement between Pepco and the District of Columbia (District) which is part of the District's larger effort to address contamination in and along the lower Anacostia River.

The purpose of the RI/FS described herein is to (a) characterize environmental conditions within the Study Area, (b) investigate whether and to what extent past or current conditions at the Site have caused or contributed to contamination of the River, (c) assess current and potential risk to human health and the environment posed by conditions within the Study Area, and (d) develop and evaluate potential remedial actions. As described later in this document, the Study Area consists of a "landside" component that will focus on the Site itself, and a "waterside" component that will focus on the shoreline and sediments in the segment of the river adjacent to and immediately downstream of the Site. The landside and waterside areas of investigation are depicted in **Figure 2**. The areas of investigation may be further adjusted or expanded during the course of the RI as warranted based on the findings of the investigation.

The RI/FS will be performed in accordance with the United States Environmental Protection Agency's (USEPA) *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Office of Solid Waste and Emergency Response (OWSER)* Directive 9355.3-01, dated October 1988, and other applicable USEPA and District Department of the Environment (DDOE) guidance documents. A generalized RI/FS process is shown in **Figure 3**. Pepco previously submitted the RI/FS Scope of Work (SOW) to DDOE and revised it to address comments from DDOE and the public. Final approval for the SOW was provided by DDOE on April 18, 2012. The approved SOW serves as a blue print for this Work Plan. Pepco also prepared a separate Community Involvement Plan (CIP), which was revised to address DDOE and public comments, and was approved by DDOE on June 18, 2012, to describe Pepco's community outreach activities during the RI/FS process.

1.1 Work Plan Purpose and Scope

The purpose of this Work Plan is to review existing data, develop a Conceptual Site Model (CSM), identify data gaps, design a data collection program to address the identified data gaps, and document the planned RI/FS activities in accordance with the previously-approved SOW. The Work Plan also presents information on project organization and schedule.

Field work activities described in this Work Plan will be performed in accordance with a Health and Safety Plan (HASP) and a Sampling and Analysis Plan (SAP) prepared in conjunction with the Work Plan. The HASP will specify necessary procedures to ensure safety of Site workers during the investigation activities for both the landside and waterside investigations. The SAP consists of two parts: (a) a Field Sampling Plan (FSP) that provides detailed guidance for all field work by defining in detail the sampling locations and the sampling and data gathering methods to be used; and (b) a Quality Assurance Project Plan (QAPP) that describes quality assurance and quality control protocols necessary to achieve Data Quality Objectives (DQOs) dictated by the intended use of the data. The HASP and SAP documents are being provided under separate cover.

DDOE will make the Work Plan (including CSM), HASP and SAP available for public review for at least 30 days by posting on the DDOE website prior to granting its approval. Upon approval of this Work Plan by DDOE (after consideration of public comments), Pepco will implement the activities outlined in this document. The areas of investigation and sampling locations may be adjusted or expanded (with DDOE approval) during the course of the RI as warranted based on the findings of the investigation.

1.2 Work Plan Organization

This RI/FS Work Plan is organized into the following eight sections:

- Section 1 – Introduction
- Section 2 – Site Background and Setting
- Section 3 – Conceptual Site Model
- Section 4 – Work Plan Rationale
- Section 5 – RI/FS Tasks
- Section 6 – Natural Resource Damage Assesment

- Section 7 – Project Orgainzation
- Section 8 – Schedule
- Section 9 – References

Figures, tables, and appendices are provided as stand-alone sections following **Section 9**.

2 Site Background and Setting

The 77-acre Site is bordered by a District of Columbia Solid Waste Transfer Station to the north, Kenilworth Maintenance Yard (owned by the National Park Service, NPS) to the northwest, the Anacostia River to the west, Benning Road to the south and residential areas to the east and south (across Benning Road). Most of the Site is comprised of the Benning Service Center, which involves activities related to construction, operation and maintenance of Pepco's electric power transmission and distribution system serving the Washington, DC area. The Service Center accommodates more than 700 Pepco employees responsible for maintenance and construction of Pepco's electric transmission and distribution system; system engineering; vehicle fleet maintenance and refueling; and central warehousing for materials, supplies and equipment. The Site is also the location of the Benning Road Power Plant, which was permanently closed on June 1, 2012.

The Site is one of several properties along the River that are suspected sources of contamination (**Figure 4**). There have been five instances between 1985 and 2003 in which materials containing polychlorinated biphenyls (PCBs) were released at the Site. In each case, Pepco promptly cleaned up the releases in accordance with applicable legal requirements. A summary of historical environmental investigations and response actions conducted on the Site by Pepco and the USEPA is presented in **Table 1**. Nonetheless, it is suspected that these releases, and possibly other historical operations or activities at the Site, may have contributed to contamination in the river. In particular, a Site Inspection (SI) conducted for the USEPA in 2008 linked PCBs and inorganic constituents detected in Anacostia River sediments to potential historical discharges from the Site. (The results of this Site Inspection are referred to herein as USEPA 2009 SI Report.) The USEPA 2009 SI Report also stated that currently the Site is properly managed and that any spills or leaks of hazardous substances are quickly addressed and, if necessary, properly remediated.

2.1 Site Description

The geographic coordinates for the approximate center of the Site are 38.898 north Latitude and 76.959 west Longitude. A Site Plan is provided as **Figure 2**. As of June 1, 2012, operations at the Benning Power Plant have ceased as announced by Pepco Energy Services (PES) which has owned and operated the power plant since 2000. The power plant is located on the westernmost portion of the Benning Service Center site, where it occupies approximately 25 percent of the facility's 77 acres. Preparations for closing the power plant have been underway since 2007. Following the closure, the plant area will be cleaned, secured, and maintained in accordance with District of Columbia and Federal environmental regulations.

The power plant was built in 1906, and provided Pepco's first system-wide electricity supply to the District of Columbia and nearby Maryland suburbs. Over the years, the power plant had operated and subsequently retired several different generating units, reflecting advances in technology and operating on different types of fuel. Only two oil-fired steam turbine units operated at the power plant in the recent past. Installed in 1968 and 1972, together they provided 550 megawatts (MW) of electricity – enough to meet the needs of around 180,000 homes – during periods of peak electricity demand. Designed to operate a limited number of days each year, these units have operated an average of 10 to 15 days annually. Structures associated with the power plant include the generating station, cooling towers, three aboveground storage tanks (ASTs) and storage buildings. The capacities of AST #1, AST#2 and AST#3 are: 618,000; 1,847,000; and 1,984,000 gallons, respectively. The three ASTs are surrounded by secondary containment dikes. As of the writing of this work plan, all three tanks have been completely drained of fuel oil. The power plant closure will include removal of the cooling tower and AST structures.

The Service Center occupies the largest part of the property, and accommodates more than 700 Pepco employees. Service Center employees work in maintenance and construction of Pepco's electric transmission and distribution system; system engineering; vehicle fleet maintenance and refueling; and central warehouses for all the materials, supplies and equipment needed to operate the Pepco electrical distribution system.

The Site is completely surrounded by a fence with two guarded entrances. The guard shacks are staffed 24 hours a day, 7 days a week. Three active substations are located on the Site, two in the eastern portion (Substation #41 and Substation #7) and one in the western portion (Substation #45). To the south of the substations is a large asphalt-covered Pepco employee parking lot. To the south of this area are railroad tracks and Buildings 56, 57, and the transformer staging area. These areas are used for activities associated with processing used electrical equipment and associated materials brought to the Site for reconditioning, recycling or disposal. The center of the Site is occupied by buildings used for office space, vehicle maintenance, equipment repair shops and storage of hazardous waste and materials. Areas located outside of the buildings are used for new equipment storage and also temporary storage of used electrical equipment prior to disposal.

There are three active underground storage tanks (USTs) at the Site. One is a 15,000-gallon double-walled steel and fiberglass tank installed in 1988 to hold new non-PCB transformer oil. The 15,000-gallon new transformer oil UST is located within the paved yard surrounded by Buildings 54, 56 and 57. A

20,000-gallon fiberglass tank, installed in 1975, contains gasoline. A 20,000-gallon double-walled tank, installed in 1991, holds diesel fuel. All tanks have leak detection monitoring devices which test the tanks and underground piping for leaks on a monthly basis. These tanks are operated in compliance with the District's UST regulations. The locations of these USTs are shown on **Figure 5**. A separate 20,000-gallon epoxy-coated steel tank, installed in 1979 and used to store gasoline, was removed in August 2012. The DDOE UST Branch inspected the tank site after the removal took place. The soil and groundwater samples, which were collected following DDOE's inspection, did not show any detectable levels of pollutants of concern. Accordingly, DDOE issued a letter of permanent tank closure for this case. A total of six UST removals/closures in place occurred at the facility between 1989 and 1997 in accordance with the District's UST regulations. These six former UST locations are identified in **Table 1**. The tanks ranged in size from 250 gallons to 15,000 gallons. These former UST locations fall within one of the Target Areas identified in **Table 2** and **Figure 5**. Please refer to **Table 2** for further details regarding the USTs and **Figure 5** for the locations of active and former USTs.

The majority of the Site is covered by impervious material such as concrete or asphalt. Active storage areas not covered in impervious material are covered in gravel. One of the gravel-covered areas is located in the western portion of the Site, directly south of the cooling towers. This area was used at one time for the storage of coal when the power plant used coal to generate electricity. Later, this area was used to dewater sludge cleaned out from the basins located underneath the cooling towers. The area is no longer used for either purpose and is paved to grade. Railroad tracks enter the Site from the south and run to the north. The tracks were formerly used to transport coal to the power plant and are no longer active.

2.1.1 Storm Water Management

Storm water runoff from the facility is discharged to the River via Outfall 013 and Outfall 101 (**Figure 5**) under the facility's NPDES permit (DC0000094). The majority of the runoff from the facility is conveyed through a 48 inch concrete pipe which becomes 54 inch as it discharges to the River via Outfall 013. In addition, Outfall 013 was also permitted to receive cooling tower blow down and cooling tower basin wash water when the cooling towers were in operation. These towers are no longer operational, as Pepco ceased the operations at Benning Road Power Plant effective June 1, 2012. Outfall 101 receives storm water collected in transformer secondary containment basins, roadways and landscaping in the southwest corner of the property. A detailed facility drainage area map is included in **Appendix A**.

Outfalls discharging to the Anacostia River (013 and 101) are sampled on a quarterly basis under the current NPDES permit. The analytical parameters include the following:

- pH;
- Total Suspended Solids (TSS)
- Oil and grease;
- Iron;
- Cadmium;
- Copper;
- Lead;
- Nickel;
- Zinc; and
- PCBs (aroclor-1242, aroclor-1254 and aroclor-1260).

These outfalls include flows from the storm sewers determined potentially at risk for receiving PCB contaminated runoff. According to the USEPA 2009 SI Report, no NPDES violations have been recorded for the Site and USEPA has reported that no PCBs have been detected in the NPDES compliance samples. A review of Discharge Monitoring Reports (DMRs) from the first, second and third quarters of 2012 indicates no excursions for PCBs and excursions of copper, zinc and iron. Pepco also analyzes for PCB congeners as required by the NPDES permit, for monitoring purposes only.

Many storm water Best Management Practices (BMPs) (e.g., secondary containment structures, operational procedures, etc.) and controls (e.g., oil water separators, low-impact development projects, etc.) have long been in place at the facility to control the discharge of contaminants with storm water to the Anacostia River. Three water quality structures to remove total suspended solids (TSS) from storm water and two oil water separators to remove oil from process water have long been in place at the facility. A fourth water quality structure was added south of Building 88 in March 2011. Locations of the water quality structures, low impact development (LID) structures, and oil-water separators are depicted in the Site Drainage Map included under **Appendix A**.

In addition to the existing Storm Water Pollution Prevention Plan, the current NPDES Permit required Pepco to prepare three plans for improvement to stormwater management practices at the facility. These plans are as follows: The Total Maximum Daily Load (TMDL) Implementation Plan, the Iron Source Tracking and Pollutant Minimization Plan and the PCB Source Tracking and Pollutant Minimization Plan. Each plan outlined an adaptive management approach for reducing potential releases of pollutants (metals, iron, PCBs and TSS) in stormwater discharges from the Site. In July 2010, Pepco submitted the three plans to EPA for review and approval. EPA approved the plans and authorized Pepco to proceed.

The first step for implementing each plan was a detailed assessment of potential sources areas and the effectiveness of existing BMPs as part of the Stormwater Pollution Prevention Plan at the Site. Pepco conducted two stormwater sampling events followed by a comprehensive site inspection to assess site conditions associated with the stormwater drainage system and to evaluate the effectiveness of the existing BMPs. The draft findings and recommendations from these efforts were submitted to EPA in May 2012. Based on the results of the sampling events, the site inspections, and evaluations of existing control measures, Pepco is implementing additional control measures to reduce stormwater contamination at the Site. These measures are being implemented in three phases. Phase I measures consist primarily of the installation of metal and oil absorbing booms in and around storm water inlets. Phase II measures consist largely of removing stored equipment and materials from areas exposed to the weather, covering and painting exposed metal pipes, and improving housekeeping practices. Phase III measures, which include installation of additional LID structures, converting impervious surfaces to rain gardens or infiltration swales, and installation of additional filtering structures, would be considered at a future time if necessary to achieve the TMDL goals. Pepco has completed implementation of the Phase I control measures and is on schedule to complete Phase II measures by January 2013.

2.2 Area Description

2.2.1 General Land Use and Demography

The Site is located in Ward 7 in the District of Columbia, within the 20019 zip code. Ward 7 is typified by single-family homes and parks. It is home to a number of Civil War fort sites that have since been turned into parkland, including Fort Mahan Park, Fort Davis Park, Fort Chaplin Park and Fort Dupont Park. Ward 7 is also home to green spaces such as Kenilworth Aquatic Gardens, Watts Branch Park, Anacostia River Park and Kingman Island.

Ward 7 also has an extensive waterfront along the Anacostia River with riverfront neighborhoods. River Terrace, Mayfair and Eastland Gardens abut the east side of the river, while Kingman Park sits to the west. The River Terrace, Parkside and Benning neighborhoods are engaged and organized communities. Ward 7 is represented by Councilmember Yvette Alexander and is home to the Mayor of the District of Columbia, Vincent C. Gray.

This area is primarily urban with the Anacostia River bordering the area to the west. The Anacostia Freeway is the main north-south highway and East Capitol Street NE is the main east-west highway. Transportation in the vicinity of the Site takes the form of light rail or motorized vehicles. The Washington Metropolitan Area Transit Authority (WMATA) operates the light rail system in Washington, DC (known as Metrorail). The Minnesota Avenue Metrorail Station is located immediately to the east of the Site.

Approximately 19% of the population in the 20019 zip code uses Metrorail to commute to and from work, with an average of 3,274 people using the Minnesota Avenue Station per day. A large percentage of the local residents use automobiles, either singly or in carpools, to commute to and from work.

Minnesota Avenue in the vicinity of the Site is zoned as commercial. In addition, a commercial light manufacturing corridor exists along the Kenilworth Ave/Metrorail tracks. Property along Benning Road is zoned sporadically as commercial. All other surrounding areas are largely residential. Most of the houses in the area were built between 1940 and 1969. The majority of the housing units are either single-family detached or single-family attached units. There are three high schools, 21 public primary/middle schools, and five private primary/middle schools within the boundaries of zip code 20019. Of the schools reported being within the 20019 zip code, four are located within a 0.25-mile radius of the boundary of the Site: Thomas Elementary School, Cesar Chavez Middle and High School, Benning Elementary School, and River Terrace Elementary School (Google Earth).

According to the USEPA 2009 SI Report, there are no drinking water intakes located within 15 miles of the Site. The District of Columbia Water and Sewer Authority (DCWASA) provides drinking water to the surrounding area by drawing raw water from intakes located at Great Falls and Little Falls on the Potomac River, upstream from the confluence of the Potomac River with the Anacostia River (http://www.dcwater.com/about/facilities.cfm).

Based on a review of the Environmental Data Resources, Inc. (EDR) Report provided by Greenhorne and O'Mara, Inc. dated September 2009, no water supply wells are located within 0.5-mile of the Site. One United States Geological Survey (USGS) monitoring well was identified 500 feet northwest of the Site and adjacent to the Anacostia River. Upon further review, this monitoring well appears to be the USGS Soil Boring DCHP01 discussed in **Section 2.3**.

2.3 Geology

2.3.1 Regional Geology

The facility is located within the Coastal Plain Physiographic Province, which is characterized by eastward thickening sequences of sedimentary deposits. The western limit of the Coastal Plain Province is commonly referred to as the Fall Line, where the older crystalline rocks (bedrock) of the Piedmont Physiographic Province begin to dip to the southeast beneath the relatively younger sediments of the Coastal Plain. The Fall Line is located approximately five miles west of the Site.

The Coastal Plain consists of an eastward-thickening wedge of unconsolidated sedimentary deposits ranging in geologic age from Cretaceous to Recent. These unconsolidated sediments consist of gravels, sands, silts, and clays that have been deposited upon the consolidated crystalline bedrock which slopes towards the southeast. Many different depositional environments existed during the formation of the Coastal Plain sediments. Glacially influenced periods of erosion and deposition, fluvial (river) processes, and structural deformations of the sedimentary deposits have all played a part in the evolution of the Coastal Plain. As a result of these processes, the presence, thickness, and lateral continuity of these sedimentary deposits in the Coastal Plain are highly variable. A generalized regional geologic profile has been included as **Figure 6**.

2.3.2 Site Specific Geology

Based upon a review of available historical reports (**Section 9**), the soils underneath the Site consist primarily of (from shallowest to deepest): artificial fill material; Patapsco Formation; Arundel Clay unit; and the Patuxent Formation. The Patuxent Formation overlies the crystalline bedrock.

The artificial fill material at the Site primarily consists of infrastructure (utilities and structures), historical fill material used to level the Site, potential process related fill (e.g., coal ash or slag), and relatively impermeable pavement (asphalt and concrete). Fill material thickness at the Site is as much as ten feet in some areas with the exception of the vicinity of the former sludge dewatering area, where fill thicknesses ranged from 14 to 17 feet.

The Patapsco Formation is typically described as a thick maroon clay, with sand and clay of various colors. Underneath the Patapsco Formation is the Arundel Clay which generally consists of thick dark grey clay. Arundel Clay is a distinct regional confining feature with very low permeability. The thickness of the Arundel Clay varies, but has been observed to be as much as 100 feet thick (USGS, 2002). Beneath the Arundel Clay are the unconsolidated gravels, sands, and clays of the Patuxent Formation. The top of the Patuxent Formation has been reported to be located at approximately 125 to 180 feet below ground surface (ft bgs) in nearby environmental assessments (NPS, 2008). The Crystalline bedrock underneath the Patuxent Formation is located at approximately 400 feet beneath the Site.

AECOM has reviewed and compiled information from 32 geotechnical borings completed by Pepco on the Site with the deepest boring (GEO B-9) drilled to a depth of 81 ft bgs. Approximate locations of these historical soil borings are shown on **Figure 7**. Information from these borings was used to generate generalized geologic cross sections, A-A’ and B-B’ (**Figure 8**). The cross sections indicate an upper and a lower water bearing zone separated by a clay unit within the Patapsco formation. This information appears to be consistent with the findings of United States Geological Survey (USGS), Lithologic Coring

Program Boring DCHP01 (**Appendix B**). Based on a review of the borehole logs available for the Site, the Arundel Clay is located approximately 42 to 73 feet beneath the Site.

2.4 Hydrogeology

2.4.1 Regional Hydrogeology

Based on the literature reviews and information from adjacent sites, aquifers underneath the Site consist of saturated sand layers within the Patapsco and Patuxent Formation and include (from shallowest to deepest): the Upper Patapsco Aquifer; the Lower Patapsco Aquifer; the Upper Patuxent Aquifer; and the Lower Patuxent Aquifer. The Lower Patapsco and upper Patuxent Aquifers are separated by the thick Arundel Clay unit. The Arundel clay has very low conductivity and acts as a regional aquitard between the Patapsco and Patuxent Formations. The Patuxent Aquifer, located beneath the Arundel Clay, flows under confined conditions towards the east (DC Water Resources, 1993).

2.4.2 Site Specific Hydrogeology

Based on review of the lithologic logs available for the Site, the Arundel Clay is located approximately 42 to 73 ft bgs beneath the Site. The information contained in these logs suggests the water table aquifer beneath the Site is located above the Arundel Clay, in the Patapsco Aquifer, with the first occurrence of groundwater measured at 8 to 21 ft bgs. The general topography, the occurrence of shallow water table and flow patterns from adjacent sites suggest potential for the groundwater to discharge to the River. Any discharge to the River would be influenced by the tidal fluctuations near the Site.

2.5 Surface Water Hydrology and Watershed Characteristics

The Anacostia River watershed encompasses an area of approximately 456 square kilometers (km^2) (176 square miles, mi^2) within the District of Columbia and Maryland, and lies within two physiographic provinces, the Piedmont Plateau and the Coastal Plain. Watershed maps are provided in **Appendix C**. The Anacostia River begins in Bladensburg, MD, at the confluence of its two major tributaries, the Northwest Branch and the Northeast Branch, and flows a distance of approximately 8.4 miles before it discharges into the Potomac River in Washington, DC (Sullivan and Brown, 1988). Because of its location in the Washington metropolitan area, the majority of the watershed is highly urbanized. An analysis of geographic information system (GIS) layers prepared by the Metropolitan Washington Council of Governments (MWCOG) indicates that land use in the watershed is approximately 43% residential, 11% industrial/commercial, and 27% forest or wetlands, with 22.5% of the area of the watershed covered by impervious surfaces.

The Anacostia River is subject to tidal influence. Based on the United States Army Corps of Engineers (USACE) condition survey conducted in June 2007, water depths in the Study Area range from approximately 6.0 ft to 10.0 ft below Mean Low Low Water (MLLW) level. The variation in the river's water surface elevation over a tidal cycle is approximately 0.9 meters (m) (3 feet, ft). The width of the river varies from approximately 60 m (197 ft) in some upstream reaches to approximately 500 m (1640 ft) near the confluence with the Potomac, and average depths across a transect vary from about 1.6 m (5.2 ft) near Bladensburg to about 6.2 m (20.3 ft) just downstream of the South Capitol Street Bridge. During base flow conditions, measured flow velocities during the tidal cycle have been in the range of 0 to 0.3 meters per second (m/sec) (0 to 1 feet per second, ft/sec) (Katz et al., 2001).

Sedimentation has been a problem in the tidal Anacostia River since colonial times (Scatena, 1987). Estimated average annual sediment discharge into the tidal embayment of the river was 134,420 tons for 1963 and 137,600 tons for 1981. Because of the low flow velocities in the tidal portion of the river, the majority of sediment entering the tidal embayment is thought to settle and remain in the tidal river, rather than being discharged to the Potomac. Based on a variety of methods, including analyses of historical bathymetry records, dredging records, and pollen profiles of sediment bed core samples, Scatena (1987) estimated sedimentation rates in the range of 1.2 to 9.1 centimeters per year (cm/yr) (0.5 to 3.6 inches per year, in/yr). More recently, radiometric dating using Cesium-137 on cores collected near the Washington Navy Yard (WNY) and the Southeast Federal Center (SEFC) sites indicated a sedimentation rate of approximately 4.0 to 6.5 cm/yr or 1.6 to 2.6 in/yr (Velinsky et al, 2011). As the sedimentation rates were measured two to three miles downstream of the Benning Road site, the lower end of the sedimentation rates are more appropriate for the Study Area.

Based on a review of NOAA's Office of Coast Survey Navigation Chart #12289 dated October 2010, the Anacostia channel ends before the Pennsylvania Avenue Bridge, which is approximately 1.6 miles downstream of the Site. According to information provided by the USACE, the most recent navigational dredging was performed prior to 2002, and included dredging up to Bolling Air Force Base. USACE was not aware of any dredging ever occurring north of the CSX railroad bridge (1.3 miles downstream of the Site) other than the cooling water intake dredging conducted by Pepco in 1996.

2.6 Historical Removal Actions and Investigations

A summary of historical environmental investigations and response actions conducted on the Site by Pepco and the USEPA is presented in **Table 1**. The locations of these activities are shown on **Figure 5**. These activities include five investigation and cleanup efforts in response to PCB material releases, multiple petroleum underground storage tank (UST) removals and closures, due diligence studies (Phase I Environmental Site Assessments or ESAs) and various other soil removals conducted by Pepco since

1985. All of these activities and studies occurred on the Landside portion of the Study Area. In addition, Pepco also conducted three geotechnical studies (CTI, 2009; Geomatrix, 1988; and Hillis-Carnes, 2009) in different areas of the Site as part of its electric system infrastructure improvement projects. These geotechnical studies provide useful information on Site geology and hydrogeology.

In 1996, Pepco performed dredging at the power plant cooling water intake located north of the Benning Road Bridge in the Anacostia River. The dredged spoils were used to construct a wetland in the vicinity of the existing water intake. Dredging and wetland construction activities extended from the Benning Road Bridge for approximately 900 feet north (Pepco, 1996; Pepco, 1997). .

USEPA conducted a multi-media inspection at the Site in 1997 in connection with the renewal of Pepco's NPDES permit (USEPA, 1997). The inspection also included compliance determinations under the Resource Conservation and Recovery Act (RCRA) and the Toxic Substances Control Act (TSCA). (The results of this 1997 multi-media inspection are referred to herein as "USEPA, 1997.") No compliance issues were noted under RCRA. One spill involving PCB oil was noted inside Building #57; however, the release was fully contained in a secondary containment vault and no release into the environment occurred. The cause of the spill was corrected through implementing appropriate management/operating procedures. USEPA also collected two liquid samples and six residue samples from the storm drain system. A liquid sample collected at Outfall 013 failed the acute toxicity test due to presence of chlorine from a leaking relief valve that was discharging chlorine-treated city drinking water. The residue samples collected from the storm drain system indicated PCB and metal concentrations that exceeded USEPA Sediment Quality Guidelines (SQGs).

As previously noted, Tetra Tech EM, Inc. conducted an SI at Pepco's Benning Road Site for the USEPA under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program in 2008 and issued a report in 2009 (USEPA, 2009). Thirteen soil samples were collected from the former sludge dewatering area (located south of the power plant cooling towers) and 16 sediment samples and five surface water samples were collected from the Anacostia River. Several metals, polycyclic aromatic hydrocarbons (PAHs) and PCBs were detected at elevated concentrations in the former sludge dewatering area and the Anacostia River sediments. With the exception of copper, no other compounds were detected in the surface water samples. The USEPA 2009 SI Report concluded that the current management and handling of waste streams, including PCB-containing equipment and material is well organized and supervised, but linked PCBs and inorganic constituents detected in the Anacostia River sediments to possible historical discharges from the Site.

2.6.1 Regional Assessment of Anacostia River and Suspected Area-Wide Sources of Impact

This section provides an overview of sediment quality data from the Anacostia River from a regional perspective and considers data available from the general vicinity of the Benning Road Site. The purpose of this overview is to provide background relative to the current understanding of sediment quality in the Anacostia River basin and suspected off-Site sources to help formulate the work to be performed as part of this RI/FS.

For decades, there has been a broad recognition that the water quality and sediment quality in the Anacostia River is degraded due to a variety of factors, including shoreline habitat degradation, point sources, non-point sources, combined sewer overflows, input from tributaries, atmospheric deposition, storm water runoff, and refuse disposal practices (Anacostia Watershed Toxics Alliance [AWTA], undated). The problems in the river are exacerbated by the tidal nature of the lower Anacostia River; much of the flow in this portion of the river is tidal, freshwater flows into the tidal waters are relatively small (Velinsky et al., 2011), and the slow-moving water tends to allow contaminants that might otherwise be flushed from the system to settle into the sediment column.

A significant number of sediment quality studies have been completed within the Anacostia River, many of these focusing on known or suspected sources of contamination in the river. Fritz and Weiss (2009) summarized six possible sources of sediment contamination in the river, while acknowledging that additional contaminants may exist in sediment or on land abutting the river:

Source	**Ownership/Comments**	**Contaminants linked to sediments**
Washington Navy Yard (WNY)	Department of Defense (DOD), National Priority List (NPL) site.	PCBs and others
Southeast Federal Center (SEFC)	Partly GSA/partly private developer.	PAHs, metals, PCBs, and others
Poplar Point	NPS	PCBs, PAHs
Washington Gas Light (WGL)	WGL and NPS	PAHs, metals
Kenilworth Landfill (former DC dump)	NPS	Fill materials had PCBs, PAHs, metals
Pepco Benning Road	Pepco	PCBs and PAHs
Source: Fritz and Weiss, 2009		

Studies on each of these specific sites, as well as broader literature relative to Anacostia River ecology, were reviewed to assist in understanding prevailing background sediment and water quality conditions and to provide context for development of the work to be performed as part of this RI/FS. Available reports and sampling data reviewed included:

- Sediment concentrations and toxicity information from 35 databases that were compiled by the National Oceanic and Atmospheric Administration (NOAA) (http://mapping.orr.noaa.gov/website/portal/AnacostiaRiver);
- A 2001 report from the Academy of Natural Science (ANS) entitled "Sediment Transport: Additional Chemical Analysis Study Phase II";
- An undated document from the AWTA, entitled "A Toxic Chemical Management Strategy for the Anacostia River";
- A peer-reviewed paper by Velinsky et al. (2011) entitled "Historical Contamination of the Anacostia River, Washington, DC;
- A 2009 document from the AWTA entitled "White Paper on PCB and PAH Contaminated Sediment in the Anacostia River"; and
- The USEPA 2009 SI Report for the Pepco Benning Road Site, Washington DC.
- Results from the Environmental Security Technology Certification Program (ESTCP), Demonstration Program—The Determination of Sediment PAH Bioavailability using Direct Pore Water Analysis by Solid Phase Micro-extraction (http://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Risk-Assessment/ER-200709/ER-200709)

The findings of these studies consistently showed the presence of PCBs, PAHs, organochlorine pesticides, metals and to a lesser degree volatile organic compounds (VOCs) in sediment samples collected from up and down the entire Anacostia River (Velinsky et al, 2011). Velinsky et al. (2011) reported that the surficial sediment concentrations of many contaminants in Anacostia River sediments have decreased during the past few decades due to a combination of factors, including improved environmental practices, restrictions on the manufacture and use of PCBs, and the encapsulation of historic impacted sediment by the more recent deposit of cleaner sediment. For instance, based on the results of six cores collected from the lower Anacostia River, total PCB concentrations in surficial sediment fell from as much as 3000 micrograms per kilogram (µg/kg) in the late 1950's to 100-200 µg/kg in 2011.

The USEPA 2009 SI Report is the most comprehensive for surficial sediments in the vicinity of the Site. According to this report:

- Analytical results obtained during the SI sampling event indicate that the contaminants of potential concern associated with Anacostia River sediments are PAHs, PCBs and inorganic compounds (metals);
- PAHs are essentially ubiquitous in sediments of Anacostia River in the vicinity of the Site (**Appendix D**). The report also notes potential PAH sources located upstream of the Site, including numerous combined sewer outfalls;
- PCBs, specifically, aroclor-1254 and aroclor-1260 were detected in sediment samples above the screening concentrations established by the USEPA Biological Technical Assistance Group (BTAG) and NOAA for aquatic life. Several metals were also reported above these screening concentrations;
- No VOCs, semi-volatile organic compounds (SVOCs), pesticides or PCBs were reported above detection limits in the surface water samples collected during the SI. Of the inorganic constituents, only copper was detected at a concentration slightly above the corresponding USEPA Region III fresh water quality criterion; and
- USEPA concluded that historical releases from the Site contributed to the contamination in the Anacostia River sediments in the vicinity of the Site based on residue samples USEPA collected from the Benning storm water system during USEPA's 1997 multi-media inspection.

The AWTA (2000) report regarding the Anacostia River indicates that concentrations of PAHs and PCBs in sediments exceeded conservative screening-level ecological benchmarks throughout the entire river with areas of relatively greater contamination primarily oriented to depositional areas of the lower half of the river (below Kingman Lake), plus some additional, isolated locales of the river where sediment is being deposited. The AWTA (2000) report identified the following six areas of interest recommended for further investigation including the vicinity of the Benning Road Site:

- Area 1: Near O Street/SEFC/WNY (PCBs, PAHs, and metals);
- Area 2: Upstream from CSX lift bridge (PCBs and PAHs);
- Area 3: Between the 11th Street and CSX bridges (PAHs);
- Area 4: Off Poplar Point (PAHs and some PCBs);
- Area 5: Upstream from the Pepco Benning Road facility (PCBs); and
- Area 6: the area in between the "hot-spots" identified in Areas 1-5 above, and within the depositional zone of the lower river extending roughly between the South Capitol and 12th Street Bridges.

The AWTA (2000) report identified approximately 60 acres of PAH or PCB contaminated “hot spots” recommended for capping (hot spots were identified as areas with concentrations exceeding the mean plus two standard deviations; 879 µg/kg for PCBs and 35,440 µg/kg for PAHs). One relatively small hot spot was identified in the vicinity of the Site.

A review of NOAA’s 35 databases (accessed through NOAA Query Manager Program) indicates that several hundred Anacostia River surficial sediment samples have been collected from the mouth of the Anacostia River to points upstream of the Benning Road Site. Relative concentrations of total PCBs and total PAHs in surficial sediment samples within four miles of the Site are illustrated on GIS plots provided in **Figures 1** and **2** of **Appendix D**. The tabular summary below presents summary statistics for these compounds in Anacostia River sediment:

Study Area	**PCBs**				**PAHs**			
	Number of Samples	**Concentration (µg/kg)**			**Number of Samples**	**Concentration (µg/kg)**		
		Minimum	**Mean**	**Maximum**		**Minimum**	**Mean**	**Maximum**
Benning Road Study Area (a)	16	40	Not available	2,510	16	2,020	Not available	14,920
Anacostia White Paper (ANS 2000 data only) (b)	124	2	181	1,643	125	495	11,742	56,330
Anacostia White Paper (All studies) (b)	295	Not detected	579	12,000	314	100	16,619	211,300

(a) Source: USEPA, 2009. Sum of aroclors and total PAHs

(b) Source: Anacostia Sediment Capping White Paper, undated. This paper evaluates total PCBs and total PAHs from (1) an Academy of Natural Sciences (ANS) Study (ANS, 2000), which was “relatively comprehensive”, and (2) from 12 specific studies (plus the ANS study) conducted between 1990 and 2003 on the river using a variety of sampling methods and protocols.

A review of these data suggests that USEPA 2009 SI Report data, while clearly containing PCBs and PAHs, must be reviewed within the overall construct of the urbanized Anacostia River corridor. USEPA in their 1997 Multi-media Inspection Report notes that PCB concentrations in storm sewer residue at the

Site were above the SQG, but less than concentrations found in similar samples collected at WNY and SEFC. With regard to PAHs, the USEPA 2009 SI Report indicates that contaminated sediments are located upstream and downstream of the Site, and that “PAHs are essentially ubiquitous in sediments of the Anacostia River in the vicinity of the site” and that “…sources of PAHs are located upstream of the Benning Road facility. These potential sources included numerous combined sewer storm water outfalls located upstream of the site.”

Although many stakeholders are engaged in concerted efforts to prevent contaminant loading into the Anacostia River, one of the more substantial challenges is related to the combined sewer overflow (CSO) systems that serve approximately one third of the District of Columbia (AWTA, undated; http://www.dcwasa.com/wastewater_collection/css/default.cfm). The District’s CSOs are antiquated systems (many of which date back to the 1880’s) that allow urban runoff and raw sewage to bypass treatment systems during rain events. During dry periods, sanitary wastes collected in the CSO system are treated at the Blue Plains Advanced Wastewater Treatment Plant; however, during periods of significant rainfall, the capacity of the CSO system is exceeded, and a mixture of storm water and sanitary wastes is directly discharged into the District’s water bodies, including the Anacostia River. There are currently 53 permitted CSO outfalls in the District operated by DCWASA.

According to AWTA (undated), an average of 82 releases of combined stormwater and sanitary wastes occur per year due to this outdated system. At the time of AWTA report publication, these releases were reported to allow a discharge volume of approximately 2.14 billion gallons of contaminated waste-water from 11 major CSOs to enter the river system on an annual basis. DCWASA recently developed a model that predicted that in excess of 93% of CSO flow volume was contributed by two CSO systems, at Main and O Street (CSO 010, the O Street Pumping Station) approximately 3.4 miles downstream from the Site, and at the Northeast Boundary (CSO 019), approximately 1.2 miles downstream from the Site. A map showing the CSO Outfalls and drainage areas is provided in **Appendix C**.

More recent data from the DCWASA website highlights the CSO concern on the Anacostia River (http://www.dcwater.com/wastewater_collection/css/CSO%20Predictions.pdf). During the first 3 months of calendar year 2012, approximately 44.7 million gallons (MG) of CSO overflow were released into the river. Approximately 66% (29.48 MG) were attributable to CSO 019 (the Northeast Boundary CSO), whereas an additional 18.6% (8.33 MG) were attributable to CSO 010 (the O Street Pumping Station).

Potential sources of contamination to the river in the immediate vicinity of the Site include the Kenilworth Landfill and the Langston Golf Course. The following paragraphs describe these sites.

Kenilworth Park Landfill is one of several properties along the Anacostia River that are suspected sources of contamination. Kenilworth Park landfill is separated into two areas: the Kenilworth Park North (KPN) landfill and Kenilworth Park South (KPS) landfill separated by Watts Branch, a tributary to the Anacostia River (**Figure 4**), with the southern portion of the KPS being immediately adjacent to the Study Area. KPS and KPN are part of the 700-acre, Kenilworth Park and Aquatic Gardens, which is part of the National Park System. KPN operated from 1942 to 1968 and in 1968 the operations moved to KPS. By the 1970s, the entire landfill was closed and capped (with a vegetative cap), and the land was converted for use as a park (NPS, 2008). Wastes deposited in the landfills included municipal waste, incinerator ash, and sewage sludge. During its operation between 1950s and 70s, the landfill extended into the Anacostia River and no barriers were constructed to prevent migration of wastes mixed with soil into the water (AWTA, 2009). Ecology and Environment, Inc. completed remedial investigations (RIs) at KPN and KPS separately in 2007 and 2008, respectively for NPS (NPS, 2007; NPS, 2008). COPCs identified by the two RIs included: PCBs, PAHs, dieldrin, arsenic, lead and methane. The KPN RI concluded that groundwater probably is impacting some sediments adjacent to the Site (NPS, 2007). A Feasibility Study (FS) was prepared for all of Kenilworth Park (KPN and KPS) by The Johnson Company, Inc. and dated April 2012 (NPS, 2012). At the time of completion of this report and based on available information, a final remedy has not been selected for KPN/KPS sites.

Ecology & Environment, Inc. also performed a Preliminary Assessment/Site Inspection (PA/SI) of Langston Golf Course for NPS in 2001. Langston Golf Course is located along the west bank of the River across from the Site. It is one of a number of sites along the Anacostia River that were used by the District as open burning/open dumps for municipal waste disposal from approximately 1910 to 1970 (NPS, 2001). An open dump with open burning existed on the west bank of the River until the early 1950s. The former District landfill was placed directly into the Kingman Lake without any barrier, and landfill wastes mixed with soil extended into the water. The PA/SI identified the presence of chemicals (PAHs, antimony, arsenic, iron, and lead) exceeding action levels in the fill material under the Site. Lead showed elevated levels and was identified as the greatest concern among the identified chemicals. The PA/SI concluded that there are no current exposure pathways by which the landfill wastes buried under the golf course can affect public. The study also concluded that groundwater impacts on adjoining surface water are extremely slight. The study recommended that the Site be maintained in its current use as a golf course and be reevaluated if site use changes.

AECOM incorporated the findings from various studies discussed above, and response actions conducted by Pepco (discussed under **Section 2.6**) into the CSM and Work Plan development. The CSM development is discussed in **Section 3**.

3 Conceptual Site Model

Information obtained from reviewing the data described in **Section 2** regarding contaminant sources, pathways, and receptors has been used to develop a preliminary CSM of the Study Area to evaluate potential risks to human health and the environment. The CSM identifies sources of contamination, affected media, routes of migration, human and environmental receptors, and potential routes of exposure after accounting for existing institutional, administrative and engineering controls at the Site (e.g., 24-hour controlled Site access, paved surfaces and employee hazard communication training program) that may eliminate or control exposures to on-site and off-site receptors. The CSM is useful in identifying data gaps and further sampling needs, and potential remedial technologies to mitigate any identified risks. It is also important for understanding the effects of both anthropogenic and natural factors on chemical concentration patterns. This preliminary CSM is a “living document”, and will be refined in an iterative manner as new information becomes available as the RI/FS process progresses. A pictorial representation of the preliminary CSM is presented as **Figure 9** and described further in the following paragraphs.

3.1 Landside

Current understanding of potential sources and impacted media on Landside of the Study Area are discussed in **Section 2**, and summarized in **Tables 1** and **2**, and shown on **Figure 5**. A brief summary of this information as it pertains to the CSM development is provided below.

- Six petroleum USTs were either removed or closed in place in accordance with the State and Federal regulations in effect at the time of their closure. A potential exists for residual petroleum hydrocarbons at these UST sites.
- PCB cleanups were conducted at the Site as noted in **Table 1**. Residual concentrations of PCBs in subsurface soils in these areas may range from 1-25 parts per million (ppm).
- Elevated concentrations of PAHs, PCBs and heavy metals (lead, copper, nickel, vanadium and zinc) have been detected in the former sludge dewatering area immediately south of the cooling towers. Certain PAHs and PCBs exceeded the USEPA soil screening levels. This area measures approximately 14,400 square feet. No removal actions have been performed in this area; however, this area was graded and covered with gravel to prevent erosion and migration of impacted material.

- Several areas on the Site (as noted in **Table 2** and discussed in **Section 4.2.1** below) have the potential to contain petroleum hydrocarbons, PAHs, PCBs, and heavy metals given the 100-year industrial history of the Site. The site history includes former coal use and #4 fuel oil use.
- There is a significant amount of site-specific subsurface geological information available from Pepco's previous geotechnical activities and activities on adjacent sites. The data indicates the Site is underlain by the Patapsco Formation potentially containing two water bearing zones separated by a clay unit. The Patapsco Formation is underlain by Arundel Clay regional confining unit at depths ranging from 42 to 73 feet beneath the Site. Because the borings and observations were made by different consultants over a long period of time, this information should be confirmed with a limited set of new borings.
- There is limited chemical data for subsurface soil in many areas of the Site, and there are no existing groundwater monitoring wells, so current groundwater conditions are not known. In addition, the potential impacts from the KPS landfill site on Site groundwater are not well understood.
- Currently, little is known about the volumetric flux of ground water to the Anacostia River in the area of the Site. Based on the limited information available, it is possible that the shallow groundwater zones beneath the Site could discharge to the Anacostia River during the low tide conditions. As part of this RI/FS Work Plan, monitoring well installation and aquifer testing are proposed to characterize the potential for groundwater discharge. The hydraulic data will be used, along with precipitation and aquifer recharge calculations, to develop a water budget including an estimate groundwater flux from the Site.
- At the Site, the Patapsco Formation and Arundel Clay has also been identified at relatively shallow depths. Rainfall recharge to the water table is limited by impermeable surface cover, which covers the majority of the Site. The low rates of recharge to the water table would, therefore, limit discharge of groundwater to surface water from the Site. The hydraulic data collected in the RI/FS will document inflows to (e.g., precipitation) and outflows (e.g., storm water runoff, groundwater recharge, etc.) from the Site.
- The 2008 SI report indicated that historical releases via storm drains may have contributed partially to the impacts noted in the Anacostia sediments. This potential pathway will be investigated further during the RI/FS.
- The nature and extent of potential constituents of potential concern (COPC)-impacted sediment are only partially characterized or delineated along most of the Site.
- Direct and indirect human health exposure pathways on the Landside portion of the Site have been found to be incomplete or insignificant because:

1. Access to the Landside portions of the Study Area is limited by perimeter fencing and 24-hours per day, 7 days per week security;
2. The presence of impervious surfaces/gravel cover prevents contact with surface soil;
3. Contact with subsurface soil is restricted by health and safety procedures and an employee hazard communication program to prevent or manage worker's exposure during excavation activities; and
4. Groundwater is not used as a local source of drinking water.

These forms of controls are commonly employed and accepted by USEPA to prevent exposure. Pepco will evaluate the current exposure scenarios on the Landside portion of the Site to evaluate all potential pathways and receptors as part of the Risk Assessment. This evaluation will provide additional details on the effectiveness of the existing operational and institutional controls to identify potential exposure scenarios. If significant exposure is identified, the CSM will be updated and the evaluation will be expanded to include the exposure assessment and risk characterization steps.

The Site will continue to be used as a service center by Pepco for the foreseeable future, and Pepco has no plans to redevelop any portion of the Site. Pepco agrees that the exposure scenarios may change depending on the future Site use, if the Site were ever sold or redeveloped. Pepco will qualitatively evaluate the potential for exposure to site media under hypothetical future exposure scenarios for the Landside portion of the Site as part of the Risk Assessment, taking into account existing institutional controls. The outcome from this evaluation will be documented in the Remedial Investigation report for future site management decisions in the event of a proposed change of site use or ownership.

In the event that a chemical abnormality is detected (e.g. significant VOCs are detected) in the soil and groundwater at the land portion of the Site, then the Human Health Risk Assessment Work Plan (**Appendix E**) will be updated to include the resultant effects to any potentially affected exposure pathways.

3.2 Waterside

The Waterside CSM explores the potential past and present mechanisms of constituent movement from the Site into the Anacostia River as well as the distribution of various sediment environments/habitats in the river as they might affect constituent distribution. The CSM summary presented in this section describes the origin (sources) of COPCs, as well as potential transport pathways, exposure pathways, and receptors. The CSM will be updated as more data becomes available through the implementation of RI/FS activities. Several sources of COPCs in sediment in the vicinity of the Site may exist, including:

- Historic discharges through Outfall 013 and overland flow from the Landside portion of the facility;

- Groundwater which may discharge to the surface water of the River;
- Storm sewers from other facilities, combined sewer outfalls, and sites such as the Kenilworth Landfill and Langston Golf Course former landfill; and
- Industrial activities in the upper anthropogenically-impacted Anacostia River and its main branches and tributaries.

Additional CSM elements include the following:

- COPCs in sediments associated with the Site may include PCBs, PAHs, and metals resulting from operation and maintenance of the power plant and equipment associated with Pepco's electrical transmission and distribution system, as well as chemicals which may have been released from other site- or non-site-related activities;
- Sedimentation rates in the river may have resulted in sediment deposition of COPCs on top of sediments adjacent to the Site from sources not related to the discharges from the Site;
- Likewise, sedimentation of the river has the potential to encapsulate historical discharges from the Site into sub-surficial horizons beneath the bio-active zone (the bio-active zone is the upper 4 to 6 inches of sediment that contains the benthic organisms);
- On-going sources associated with storm water discharges and existing control measures will be evaluated to determine the need for additional controls;
- Potential transport pathways for COPCs from the Benning Road facility to adjacent sediments are sheet flow from the Site to the water column and sediments, as well as historic storm water discharges to the water column and sediments.
- The tidal influence of the river is unknown with regards to COPC distribution adjacent to the Site; and
- Human health exposure pathways are most likely associated with consumption of contaminated fish, although the Anacostia River and Potomac River are currently under a fish consumption advisory imposed by the DDOE. This advisory provides the following advice to the public relative to consumption of fish from DC waters and indicates that the advisory is due to the presence of PCBs and other chemical contaminants:

  Do Not Eat: channel catfish (*Ictalarus punctatus*), carp (*Cyprinus carpio*), or American eel (*Anguilla rostrata*)

  May Eat: One-half pound per month of largemouth bass *(Micropterus salmoides)* or one half-pound per week of sunfish or other fish

  Choose to Eat: Younger and smaller fish of legal size

  The practice of catch and release is encouraged.

In addition, the DDOE advisory provides limited guidance regarding skinning of fish, trimming fat, and cooking of fish.

- Ecological exposure pathways are most likely associated with benthic macroinvertebrates, fish, and piscivorous birds and mammals.

4 Work Plan Rationale

This section describes the data quality objectives (DQOs) development process and presents an overall approach for completing the RI/FS.

4.1 Data Quality Objectives

The DQOs for the Landside and Waterside areas were developed using the USEPA's DQO process, a multi-step, iterative process that ensures that the type, quantity, and quality of environmental data used in the decision making process are appropriate for its intended application. The Landside and Waterside DQO development process is presented in **Tables 3** and **4,** respectively.

The DQOs for this investigation are:

- To characterize environmental conditions within the Study Area and refine the CSM
- To collect additional data to update existing Landside and Waterside datasets from previous investigations so that nature and extent of impacts can be defined
- To collect data to determine whether and to what extent past or current conditions at the Site have caused or contributed to contamination of the Anacostia River
- To collect data within the Anacostia River to identify potential Site-related, near-Site and far-Site sources of COPCs in sediment and surface water
- To collect hydraulic data to better understand the site-specific hydrogeology and evaluate the volumetric flux of groundwater to the Anacostia River
- To collect data to better understand the Site storm drain system and associated discharge to the Anacostia River at various outfalls
- To collect data to support performance of Human Health and Ecological Risk Assessments
- To collect data to support a Natural Resources Damage Assessment (NRDA) evaluation
- To collect data to support development and evaluation of remedial alternatives

There are several analytical levels of data quality available to achieve the DQOs. These levels are typically designated as follows:

- **Level I** – Field screening or analysis using portable instruments, calibrated to non-compound specific standards;

- **Level II** – Field analysis using portable instruments, calibrated to specific compounds;
- **Level III** – USEPA recommended performance based methodologies such as those outlined in USEPA SW-846;
- **Level IV** – USEPA Contract Laboratory Program (CLP) Routine Analytical Services (RAS) methods; and
- **Level V** – Other internationally-recognized and/or non-standard analytical methods.

Field-screening data will be used in the Landside investigation to interpret lithologic units and aid in the identification of the presence or absence of a release in an area. In addition, field screening data will be used in the Waterside investigation to understand the depth of the water column, configuration of the river bottom and identification of utilities in the proposed investigation area.

Field screening data will be used as part of a weight-of-evidence approach in conjunction with laboratory data and geologic information to delineate impacts in the context of the CSM. Additionally, field screening and observations will be used by the field team to evaluate and adjust sampling depths and locations as needed. This approach to the field investigation is a key component of this dynamic work plan.

Landside and Waterside field screening activities will be conducted under Level I data quality protocol. Both Landside and Waterside field measurements [i.e., pH, temperature, turbidity, photoionization detector (PID) with 10.6 eV lamp, x-ray fluorescence (XRF)] will be completed under Level II data quality protocol. Samples submitted for fixed laboratory analysis and accredited on-site mobile laboratory will be analyzed, at a minimum, under Level III data quality protocol. Level IV or V could be used for specialty methods such as high resolution PCB analysis or forensic analysis.

4.2 Work Plan Approach

In order to meet the RI/FS project schedule expeditiously, the planned investigation will incorporate an iterative, dynamic approach to the investigation using field screening techniques, field-based decision-making and real-time evaluation of data while crews are still in the field, as necessary. Under the oversight of the District and the Pepco Project Manager, the AECOM Field Team Leader will be given authority to adjust sampling locations, as appropriate based on field conditions. The sampling program will incorporate an adaptive management approach that allows the use of screening parameters to screen larger areas to help focus resources on potential problem areas. Field and laboratory data will be rapidly uploaded to the project database to allow a timely evaluation of results, and thereby allowing near real-time adjustments to the field investigation, as necessary, to complete the delineation of impacts encountered. Pepco will use an accredited mobile laboratory to facilitate rapid characterization.

4.2.1 Landside Investigation

The Landside investigation program will include three phases of work, each phase providing necessary information for the planning of the successive phase of work. Landside data collection program is summarized in **Table 5**. Phase I activities will involve sampling of surface soils and storm drains. In addition, Phase I will first involve the screening of the Site using electrical resistivity imaging (ERI) to identify potential anomalies, followed by soil borings to calibrate the electrical signals with lithologic and chemical sampling.

ERI also provides useful information on soil and groundwater zones impacted by light non-aqueous phase liquids (LNAPLs) and/or dense non-aqueous phase liquids (DNAPLs). These zones will be targeted during Phase II using the direct push technology (DPT) (Geoprobe®) borings to delineate potential zones of impact and identify any continuing sources of contamination. Additional direct push borings will be conducted during Phase II to collect soil and groundwater samples and characterize horizontal and vertical extent of any impacts found using PID and XRF field instruments, and total petroleum hydrocarbon (TPH) and PCB aroclor analysis using an on-site mobile lab.

Phase III will involve a detailed hydrogeologic investigation involving the installation of monitoring wells, water level gauging, aquifer testing and groundwater monitoring. The locations of the monitoring wells will be based on results from ERI and DPT data collected in Phases I and II.

To help guide all of these Landside investigation activities, AECOM identified several “Target Areas” on the Site based on historical investigations and remediation, UST closures, former and current operations that could have a potential for Site impacts. These Target Areas are presented in **Table 2** and depicted on **Figure 5**. It should be noted that Pepco completed investigations and/or cleanups in Target Areas with PCB and petroleum releases in accordance with the District regulations. Some target areas have been identified based on PCB handling operations, which are in compliance with applicable regulations, and current fuel storage. Therefore, the purpose for these Target Areas is to serve as a guide to steer the RI field activities. Target Areas may be grouped together during the initial phases of investigations. As investigation activities proceed in an iterative fashion, they will focus on any impacts observed in or around the Target Areas.

4.2.2 Waterside Investigation

The Waterside investigation will focus on defining the nature and extent of COPCs in sediments adjacent to the Site and at selected background locations. There is a high degree of uncertainty associated with sediment COPCs originating from the Site, due to potential contributions from other sources, the nature of the tidal river system, and sediment deposition. After a review of Site-related documents, the following potential data gaps were identified:

- The horizontal and vertical extent of COPC-impacted sediment proximate to the Site requires further delineation;
- The potential contribution of groundwater that discharges from the Site to the river is not well understood;
- The source(s) of any COPCs in sediments proximate to the Site have not been adequately determined. Given the high potential for other sources of these compounds, it is unlikely that all COPCs identified within the sediment would be attributable solely to the operations at the Site. Developing an understanding of Site-related impacts to surface water and sediment in this urban river system requires information such as PAH and PCB fingerprinting/pattern matching (referred to as forensic analysis).
- The effects associated with potential exposure to Site-related sediment COPCs on Anacostia River human and ecological receptors have not been adequately assessed and the potential role of non-COPC stressors such as grain size, CSOs, seasonal fluctuation in dissolved oxygen (DO) is not adequately understood. It is possible that these non-chemical stressors also play a role in posing a potential risk to ecological health in the vicinity of the Site.

This Work Plan has been designed to address these data gaps, as well as other topics, through the collection of additional data and further review of existing information.

Data for the Waterside area will be collected in two phases. Phase I will involve bathymetric and utility surveys at on-site and background locations. Surface water and sediment sampling will be conducted under Phase II. Sediment samples will be collected using barge-mounted Vibracore™ equipment. An on-site mobile lab will be used to characterize the extent of sediment impacts using PCBs aroclor analysis.

5 RI/FS Tasks

This section provides a brief discussion of the various RI/FS tasks. Detailed sampling procedures, operating procedures, calibration and analytical procedures will be discussed under the SAP.

5.1 Project Planning

The project planning task involves preparing necessary project plans (Work Plan, SAP and HASP), obtaining all required permits, clearances, and site access. In addition to obtaining utility clearances as needed, the following permits requirements have been identified:

- Approval of the Work Plan, SAP and HASP by DDOE.
- Drilling permits for the landside and waterside sampling activities from the District Department of Consumer and Regulatory Affairs (DCRA).
- Permit from USACE, Baltimore District, for working in the Anacostia River. It is expected that the sampling would be covered under the Nationwide Permit (NWP) #5 or #6. An individual Water Quality Certification must be obtained from DDOE to authorize the use of these NWPs.
- A permit would be required from the NPS to access the River and conduct sampling in the River.

5.2 Field Investigation Activities

The field investigation activities are designed to characterize conditions in soil, groundwater, surface water and sediment; further refine the CSM; and collect data to support risk assessment and NRDA. Data gaps identified during the review of existing data were used to guide the scope of this investigation. Field investigation activities are divided into Landside and Waterside activities and are described below. All field investigation activities will be conducted in accordance with the approved SAP and HASP.

5.2.1 Landside Investigation

<u>Phase I, Task 1: Utility Clearance</u>

Various forms of underground/overhead utility lines or pipes may be encountered during site activities. Utility plans will be obtained and reviewed while selecting sampling locations. Prior to the start of intrusive operations, utility clearance will be conducted by public and private utility locators in proposed investigation areas. Miss Utility will be contacted for the identification of all recorded public utilities servicing the Site. Following public utility identification, a private utility locating contractor will be utilized to identify and locate any utilities that Pepco is unable to clear. A review of available as-built drawings will be conducted to locate any additional subsurface structures prior to intrusive activities. If insufficient data is available to accurately determine the location of the utility lines within the proposed investigation area, AECOM will hand clear or use soft dig techniques to a depth of at least five ft bgs in the proposed areas of subsurface investigation.

Phase I, Task 2: Surface Soil Sampling

The purpose of surface soil sampling is to evaluate surface soil quality and to help plan the DPT investigation. The analytical data will also be used to develop correlations with field instruments to be used for screening during Phase II activities. Surface soil samples will be collected from within the top 12 inches of the subsurface after coring through existing pavement or ground cover. Each sample will be screened with a field PID and XRF instrument and the results will be recorded. As shown in **Table 5**, a total of 25 surface samples will be collected from various portions of the Site. The surface soil samples locations will be distributed to get a good coverage of the entire facility, while using some biased samples to address the Target Areas presented (**Figure 10**).

Phase I, Task 3: Storm Drain Sampling

The purpose of storm drain sampling is to determine, if current or historical discharges from the storm drain system contributed to contamination in the River. Pepco proposes to re-sample the six locations sampled during the 1997 USEPA Multi-media Inspection, and in addition sample the influent and effluent sides of Outfall 013, and Outfall 101, for total of up to nine locations. Collection of residue and water samples is contingent upon availability of sampling media and access to the locations at the time of sampling. A map showing the tentative sample locations is provided as **Figure 11** and analytical particulars are presented in **Table 5**. Up to two of these locations will be selected for forensic analysis.

Phase I, Task 4: Electrical Resistivity Imaging (ERI)

ERI techniques are commonly used in environmental site characterization and involve the measurement of electrical conductivity/resistivity of the ground. A variation of the ERI technology known as GeoTrax™ is offered by Aestus, LLC. Each GeoTrax Survey™ will be performed by installing specialized 3/8-inch diameter stainless steel electrodes into the ground along a straight line or transect that could run hundreds of feet long depending on the target depth of investigation. The electrodes are hammered into the ground just far enough to get electrical contact with the earth, typically 6 to 15 inches. The resulting data is processed using proprietary algorithms to produce a color-coded, high-resolution, 2-dimensional or 3-dimensional image that can be used to identify anomalies that represent changes in subsurface lithology, buried objects, and LNAPL/DNAPL plumes, and chlorinated compounds such as PCBs. GeoTrax™ imaging can be used as a screening tool and when calibrated with actual lithologic and chemical data collected from a direct push boring, it provides a rapid site characterization tool. Up to eight GeoTrax™ transects will be run along cross section A-A', in the former sludge dewatering area, and other Target Areas to the top of the Arundel Clay unit as identified in **Figure 10**. Calibration borings will be performed using a combination of soil borings in Phase I and direct-push borings under Phase II.

Phase I, Task 5: Soil Borings

A geotechnical investigation will be conducted to aid in the verification of the existing data and design of monitoring wells. Five soil borings (SB-1 through SB-5) will be installed at the approximate locations shown on **Figure 7**. In addition, **Figure 7** shows the area on the NPS property where DDOE proposes to place an additional geotechnical soil boring. The placement of a boring in this area will require a permit from the National Capital Parks – East (NCPE). Further, it is Pepco's understanding that this property falls within a historical/cultural resource protection area and as such any borings placed in this area would require the State Historical Preservation Office (SHPO) clearance and potentially archeological logging. Pepco will use reasonable efforts to obtain the required permit and approvals.

The soil borings will be advanced approximately 10 feet into the confining layer (Arundel Clay) using a Hollow Stem Auger (HSA) Drill rig to obtain split-spoon and Shelby tube samples. Split-spoon samples will be obtained using the standard penetration test (SPT) in accordance with the American Society for Testing and Materials (ASTM) Standard D1586. The blow counts (hammer strikes) required to advance the sampler a total of 18 inches or 24 inches will be counted and reported. Soils will be logged in accordance with the Unified Soil Classification System (USCS). Split spoon samples will be collected continuously from the surface to the water table and then every five feet from the water table to the terminal depth of the boring. Soil samples will be field screened for VOCs using a calibrated PID. Up to five Shelby tube or disturbed samples (from drill cuttings) will be collected from each boring in accordance with ASTM Standard D1587 and analyzed for ASTM Permeability, Grain size and Atterberg limits. To aid in the identification of the Arundel Clay, three Shelby tube samples will be collected from the bottom (approximately 10 feet into the confining unit) from three selected soil borings and analyzed for ASTM Permeability, Grain size and Atterberg limits. One split-spoon soil sample from each soil boring will be collected from the middle of the water table aquifer and analyzed for ASTM Grain size and Atterberg limits.

Groundwater levels will be collected during installation of the geotechnical borings and 24 hours following completion of the borings. Dedicated investigative tooling and materials will be properly decontaminated in accordance with the SAP. Disposable materials and supplies (e.g. tubing, personal protective equipment (PPE), etc.) will be disposed of with the municipal waste. Soil cuttings generated during boring installation will be temporarily staged on-site in 55-gallon drums while awaiting characterization.

Upon completion of soil boring activities, soil borings will either be converted to monitoring wells (if determined feasible) or properly abandoned with grout using a tremie pipe to the maximum extent possible. The ground surface will be restored to match the existing surface cover. Soil boring locations will be surveyed (x, y and z-planes) into existing site datum by a licensed surveyor.

Phase II, Task 1: DPT Subsurface Investigation

Following the completion of Phase I, DPT borings will be advanced in and around Target Areas identified on **Figure 5** as well as any anomalies identified by the ERI activities. As described in **Section 2**, Target Areas identified on **Figure 5** are for guidance purposes only. Several of the Target Areas that are geographically close may be grouped together and investigated as one area based on field logistics. A total of 40 DPT soil borings are planned. Soil borings will be advanced to approximately 5 ft below the first water table or refusal, whichever is encountered first. Soil cores will be screened continuously using a PID. A field geologist will continuously log the cores in accordance with the USCS to the terminal depth of the boring.

Soil samples will be collected from three depths and subjected to screening using an XRF field instrument, and total petroleum hydrocarbon (TPH) and PCB aroclor analysis using an on-site mobile laboratory. Boring locations and characterization parameters will be adjusted based on the screening data. Investigation activities will focus on any Target Areas where impacts are observed. Groundwater samples will be collected in-situ from the within the top five feet of the water table using a discrete sampling DPT tool. It should be noted that groundwater sample intervals may be adjusted based on the results of the ERI screening. Groundwater and soil samples will be submitted for laboratory analysis as noted in **Table 5**. A subset (approximately 20%) of the samples will be subjected to metals analysis for confirmation of the field XRF data.

Reusable investigative tools and materials will be properly decontaminated in accordance with the SAP. Disposable materials and supplies (e.g. direct push liners, tubing, PPE, etc.) will be rinsed and disposed of as ordinary solid waste. Soil cuttings and purge water generated during boring installation will be temporarily staged on-site in 55-gallon drums while awaiting characterization.

Upon completion of soil boring activities, soil borings will be properly abandoned with grout following the DDOE guidance. The ground surface will be restored to match the existing surface cover. Soil boring locations will be surveyed (x, y and z-planes) into existing site datum by a licensed surveyor.

Phase III, Task 1: Monitoring Well Installation

Following the completion of Phase II, monitoring wells will be designed and installed based on the results of ERI, DPT, and geotechnical investigative activities. The number or location of the wells cannot be determined at this time. Pepco will prepare and submit a Work Plan addendum to DDOE within 45 days of the completion of Phase II field activities to describe the selection of monitoring well locations and confirm construction details. Upon DDOE approval of the Addendum, monitoring wells will be installed using a drill rig equipped with 12.25-inch outer diameter hollow stem augers (8.25-inch inner diameter). Split-spoon samples will be obtained in accordance with the ASTM Standard D1586.Soils will be logged in accordance with the USCS. Split-spoon samples will be collected continuously from the surface to the water table and then every five feet from the water table to the terminal depth of the boring. Soil samples collected from the vadose zone will be field screened using a PID for VOCs.

The monitoring wells will be constructed using two-inch diameter Schedule 40 polyvinyl chloride (PVC) well casing and slotted PVC well screen. If two water-bearing zones within the Patapsco formation are confirmed, the wells will be constructed of 2-inch diameter PVC casing as nested wells with two discrete screened intervals. A certified clean sand filter pack will be installed in the annular space between the borehole and the well screen and casing from the bottom of the boring to approximately one foot above the screened interval. Approximately two feet of bentonite clay will then be placed on top of the sand pack and hydrated to form a seal above the sand. After allowing the bentonite to set, the remaining portion of the annular space will be tremie grouted with a bentonite-portland cement mixture to grade. Each monitoring well will be completed inside a traffic-rated 18-inch road box/well vault. Upon completion of monitoring well installation, construction logs will be completed providing the details of the well construction and depth.

Following installation, the wells will be developed using a surge block and submersible pump. The surge block will be used inside the well to flush fine sediments from the sand filter, grade formational sediments, and remove the sediment lining on the borehole that is inherent in most drilling methods. After the well is surged, a submersible pump will be lowered into the well and groundwater will be withdrawn. Temperature, pH, specific conductance and turbidity readings will be monitored and pumping will proceed until the readings have stabilized or five well volumes have been removed.

Drill cutting and development water will be managed as described in **Section 5.2.3** below. Top of casing elevations and locations for each groundwater monitoring well will be surveyed into existing Site datum by a licensed surveyor. In addition, one or more river gauging stations will be established in the Anacostia River and surveyed as well.

Phase III, Task 2: Monitoring Well Gauging and Sampling

All groundwater monitoring wells will be allowed to equilibrate for a minimum of 7 days after development prior to groundwater sample collection. Prior to the groundwater sampling, a site-wide water level measurement event will be performed during the period of slack tide in order to determine groundwater elevations at the Site and accurately characterize local groundwater flow conditions. In addition, the Anacostia River elevations will be determined concurrently by collection of water levels at gauging stations with referenced elevations surveyed to the same control datum as the monitoring wells. The surface water elevations will also be measured during the period of slack tide to determine the elevation relationship between the site groundwater and the Anacostia River. Two such gauging events will be conducted.

Groundwater samples will be collected from monitoring wells with portable bladder pumps using disposable bladders and low-flow sampling techniques. Groundwater samples will be collected and analyzed as noted in **Table 5**. Disposable sampling materials, decontamination water and purge water will be containerized and managed as described in **Section 5.2.3** below.

Phase III, Task 3: Aquifer Testing

Aquifer testing will be conducted using slug testing techniques. Approximately two weeks following initial pumping activities, slug testing will be conducted on select monitoring wells to characterize hydraulic properties of the water table aquifer. The tests will consist of falling-head and rising-head slug tests to determine the hydraulic conductivity of the material in the vicinity of each well. The tests will proceed until the water levels have recovered to within 10% of the static pretest levels or 24 hours have elapsed. Slug testing data will be interpreted using the Bouwer-Rice solution for an unconfined aquifer on Aqtesolv™ or similar aquifer test analysis software.

5.2.2 Waterside Investigation

The Waterside investigation is designed to evaluate potential sources of constituents in the sediment of the Anacostia River in the vicinity of the Site, provide horizontal and vertical delineation of constituents in the sediment, and determine the potential effects associated with exposure to sediment constituents on Anacostia River receptors (i.e., human and ecological receptors). Based on the results of prior sampling, the investigation will focus on PAHs, PCBs, and metals, with limited screening samples for VOCs, SVOCs, pesticides, and dioxins/furans. This information will be used to support the risk assessments and the NRDA.

This investigation will primarily address sediment conditions within the Waterside Investigation Area, an area of the Anacostia River approximately 10 to15 acres in size including approximately 1,500 linear feet to the south (approximately 1,000 feet south of the Benning Road Bridge) and 1,000 linear feet to the north of the Site's main storm water outfall area (**Figure 10**). The proposed study area is based on its proximity to the Site and results from the USEPA 2009 SI Report.

The Waterside investigation will focus on defining the nature and extent of constituents of potential concern in sediments adjacent to the Site and at selected background locations. A progressive elimination approach will be incorporated into the Waterside sampling program to allow the use of screening parameters to screen larger areas and help focus resources on potential problem areas. Following the evaluation of these findings, additional investigation may be recommended to refine the delineation of chemical data or provide additional site-specific information from selected portions of the study area.

The Waterside investigation will use a systematic sampling grid to determine sediment and surface water sampling locations during the Waterside investigation (**Figure 12**). This grid will consist of 45 sampling locations on ten (10) sampling transects positioned perpendicular to the shoreline. Three to five sampling locations will be positioned evenly spaced along each transect. Additional sampling locations will be positioned between each transect and close to Outfall 013 and two sampling locations will be placed in the wetland area for a total of 45 sampling locations within the Waterside Investigation Area. The exact locations of the sampling locations may vary according to the conditions of the substrate, the nature of depositional processes observed in the geophysical survey, and agency consultation prior to the field effort.

At each of the 45 sample locations, field measurements will be taken, surface sediment will be collected and inspected, and sediment cores collected. Surface water samples will be collected at a sub-set of the locations within the grid. The locations will be sampled using a motorized boat. While collecting the sediments at each station, the boat will be anchored. The vessel will be mobilized in such a way as to minimize the potential for disturbance of the sediment and surface water via wave or propeller action. A differential global positioning system (DGPS) unit will be used to record all sample station coordinates to sub-meter accuracy. The sampling program will include surface sediment samples and subsurface Vibracore™ samples. While this sampling plan provides a framework for the proposed sampling approach, field observations will determine the final sample selection and which samples are chosen for laboratory analysis.

Ten (10) additional surface sediment and surface water sampling locations will be chosen up river, down river, and across from the Site to provide additional background and baseline area-wide data. An effort will be made to obtain background samples from locations with similar ecological parameters (e.g., sediment grain size, water depth, flow regime, tidal influence, etc.) as those adjacent to the Site.

Figure 13 presents a preliminary identification of fifteen potential background/reference sampling locations; these locations are also described in **Table 6** and were selected based on review of data from historical sampling locations, as well as review of data relative to physical and anthropomorphic conditions and features of the river. A subset of 10 of these stations will be selected by Pepco and the DDOE for this background program. Other adjustments to sampling locations may occur as a result of the field conditions. The selected background locations include:

- two locations upstream on the northeast and northwest branches of the river that are also the MDE fish tissue locations,
- one location at the confluence of those two branches,
- two locations upstream in between the confluence and the Site,
- three locations on tributaries upstream of the Site,
- four locations in the channel adjacent to Kingman Lake opposite the Site, and
- three locations downstream and outside of the influence of the Site.

As described in more detail below, the field activities for the Waterside investigation are as follows:

- Bathymetric and utility survey;
- Surface sediment sampling;
- Subsurface sediment sampling using Vibracore™;
- Surface water sampling; and
- Laboratory testing including forensics evaluations.

A summary of the data types, quantities, analytes and methodologies, and data uses is presented in **Table 6**. Permits or access agreements that may be required from the District of Columbia, United States Coast Guard (USCG), the USACE and the National Park Service (NPS) will be obtained prior to initiation of the field program.

The following sections describe the field activities that will be performed during the Waterside investigation. All of the sampling locations within the Waterside Investigation Area are presented in **Figure 12**. Additional samples will be collected from the background sampling areas to be identified based on information in **Appendix D**. Specific procedures for the field work are described in the SAP.

Phase I, Task 1: Bathymetric and Utility Surveys

Prior to initiation of any intrusive sediment sampling, a bathymetric and utility survey will be conducted in the Waterside Investigation Area. The bathymetric survey will provide a basis for understanding the depth of the water column and the configuration of the river bottom and will be used to prepare a contour map of the top of the sediment surface in and around the investigation areas. The utility survey will be conducted to identify river bottom pipelines, cables and lines that may be located in the planned area of investigation. Their presence and global positioning system (GPS) benchmarked locations will be noted on a base map of the area.

A specialty subcontractor will perform the utility survey within the Waterside Investigation Area identified in **Figure 12**. A limited bathymetric survey will also be performed at background sampling locations to assure the similarity of river bottom morphology with that at the site and to confirm the lack of utility crossings at these locations. Side scan sonar and/or magnetometer surveys will be used to identify any utilities or large pieces of debris that might interfere with the proposed sampling activities.

It is anticipated that parallel survey lines will be run at 50-foot intervals throughout the survey area. Additional tie lines will be run perpendicular to these lines. The contractor will use a survey-grade precision fathometer (Odom Hydrotrack Fathometer or equivalent) to collect continuous water depth data along the track lines. The contractor will continuously log each geographic position (X-Y location) using DGPS. Depth and geographic location will be sent to the survey computer using the Integrated Survey Software package. Time will be continuously recorded; therefore, tidal correction will be available for post-processing using data from a tide gage that will be installed and surveyed prior to the bathymetric survey. Survey accuracy will follow the USACE Manual No. 1110-2-1003 for hydrographic surveying (USACE, 2002).

Phase II, Task 1: Surface Water Sampling

Surface water sampling will be conducted prior to sediment sampling to assure the integrity and representative nature of the sample. A total of twenty (20) water samples will be collected from immediately above the sediment-water interface in order to capture potential impacts of groundwater discharge. Ten (10) samples will be collected from within the Waterside Investigation Area and ten (10) samples will be collected from background sampling locations.

The sampling boat will be located above the selected sampling location using GPS coordinates. Upon arrival at each sampling station, a depth-to-sediment measurement will be collected to record the water depth. The water depth will be recorded with an accuracy of ±0.1 feet. Two sets of field measurements of water quality will be taken at each station. One measurement will be taken near the water surface, approximately one foot below the water surface, and a second measurement within one foot from the top of the sediment surface. Only one water quality measurement will be taken at mid-water depth and at stations where the water depth is less than three feet. The water quality parameters to be measured in the field include the following:

- Temperature (degrees Celsius, °C);
- Dissolved Oxygen (milligrams per liter, mg/L);
- pH (standard units, S.U.);
- Turbidity (Nephelometric Turbidity Units NTU); and
- Conductivity (micromhos per centimeter, µmhos/cm).

The surface water sample for chemical analysis will be obtained from approximately one foot above the sediment-water interface using a depth specific sampling device. The water samples will immediately be packaged for shipment to the laboratory following preservation and management protocols described in the accompanying SAP.

Surface water samples will be analyzed for the following parameters:

- In all samples – Total and dissolved phase metals, PCB aroclors, PAH16, and hardness.
- In a sub-set of up to 10 samples – O&G, VOCs, SVOC, pesticides, dioxins/furans.

A summary of the analytes and methodologies is presented in **Table 6** and details on chemical analyses are provided in the SAP.

<u>Phase II, Task 3: Surface Sediment Samples</u>

The sediment sampling activities outlined below will conform to USEPA and ASTM standard methods where appropriate (ASTM, 2000a; ASTM, 2000b; USEPA, 2001).

A surface sediment grab sample will be collected at all 45 of the sampling locations shown in **Figure 12**, in addition to 10 background locations (total of 55 surface sediment samples). If obstructions such as boulders or cobbles are encountered at a specific station, the location of the station may be changed to collect sediment samples as required. In the case that boulders or debris are encountered, samples will be collected as close as possible to the specified sample location.

All surface sediment samples will be collected from a depth of 0 to 6 inches below sediment surface with a Petite Ponar grab sampler or the equivalent. During this phase of work, the surface samples will be logged for visual and physical observations. A portion of the sample will be placed in a pan, inspected for sediment type, color, odor, obvious signs of biota and other notable features, and then returned to the river. The remainder of the sample will then be prepared for shipment to the laboratory.

Field personnel will record field observations of the physical characteristics of the sediment encountered at each sampling station and also important observations regarding the physical characteristics of the study area. Information recorded will include:

- Sample station designation;
- Presence of fill material, coal or coke, or asphalt- or tar-like materials;
- Presence or absence of aquatic vegetation;
- Sediment color, texture, and particle size; and
- Odor and presence of sheens or LNAPL and/or DNAPL.

The 55 surface sediment samples used for chemical testing will be processed by personnel in the field. The samples will be screened using a PID and oversized material such as twigs, shells, leaves, stones, pieces of wood, and vegetation will be removed by hand. The grab sample will be removed from the sampling device using a stainless steel spoon/scoop and placed in a decontaminated 1-gallon stainless steel or Pyrex glass mixing bowl. Each sample will be visually examined for physical characteristics such as composition, layering, odor, and discoloration. Samples for VOC, Simultaneously Extracted Metals (SEM), and acid volatile sulfide (AVS) analyses will be collected prior to sediment homogenization. The remaining sample will be homogenized in the mixing bowl and placed in appropriate sample containers. Sediment sampling equipment such as bowls, spoons, augers, and dredges will be decontaminated prior to and following sample collection as described in the accompanying SAP. Each jar will be properly labeled with the name of the study site, the station location designation, the time of collection, the date of collection, and name of collector. Following sample preparation, glass jars will be kept at 4ºC. Surface sediment samples will be analyzed for the following parameters:

- In all samples – Total Organic Carbon (TOC), grain size, metals, SEM and AVS, PCB aroclors, and PAH16.
- In a sub-set of up to 20 samples - VOCs, SVOC, pesticides, dioxins/furans.

A summary of the analytes and methodologies is presented in **Table 6** and details on chemical analyses are provided in the SAP.

Phase II, Task 4: Subsurface Sediment Samples/Vibracore™ Borings

Forty-five Vibracore™ sediment borings will be completed at the sediment sampling locations shown on **Figure 12** (i.e., co-located with the surface sediment sampling locations). The sediment cores will be collected using a small boat equipped to advance a 3-inch diameter Vibracore™ sampler to a maximum depth of 10 feet below the sediment surface, or to refusal, whichever is encountered first. The ten foot target depth is based on published average sedimentation rates for the Anacostia River (approximately 4 to 6.5 cm/yr) and should provide a sediment column that includes sedimentation which generally predates the operation of the facility. A second consideration is the general limits of the Vibracore™ sampling tool which vary depending on sediment type and compaction history.

To meet the objectives for this task, the sampling will be performed as follows:

- The core sampler, equipped with a plastic liner, will be driven and extracted at each of the designated sample locations;
- The core liner will be extracted from the core barrel and split open;
- The sediment sample will be screened for organic vapors with a PID and logged for physical characteristics; and
- Samples from up to three horizons within each core will be collected.

It is estimated that up to 165 discrete interval subsurface sediment samples will be collected for laboratory analysis from the 45 sampling locations in the Waterside Investigation Area and the 10 background locations (3 horizons at 55 locations). Subsurface sediment samples will be analyzed for the following parameters:

- In all samples – PCB aroclors (performed using an on-site lab), and PAH16;
- In a sub-set of up to 20 samples – TOC and grain size; and
- In a sub-set of up to 7 samples – forensic testing to evaluate PCB and PAH origins and contributions.

If the surface sediment analyses indicate that VOCs and SVOCs are contaminants of potential concern, additional VOC and SVOC analyses will be performed on a subset of the subsurface samples.

These data will establish a database from which to further evaluate the horizontal and vertical extent of PCB and PAH constituents in river sediments adjacent to the Benning Road facility. Visually-impacted zones will be logged and the PCB data will help to define impacted areas of concern, concentration gradients, and sediment quality data gaps, if they exist. These data will serve as the basis from which to refine potential future sampling events.

A summary of the analytes and methodologies is presented in **Table 6** and details on chemical analyses are provided in the SAP. The Waterside sampling program will include the collection of up to seven (7) sediment samples for submittal to a specialty forensics laboratory for fingerprinting purposes. Testing will be performed to identify PCBs and PAH contributors to the total PCB and PAH load identified in the samples. Testing may also include upstream (i.e., background) samples, if field observations indicate an alternative potential source of PCBs and PAHs that warrants further consideration. This forensic analysis will be used to differentiate between Benning Road sources and other potential sources of PCBs and PAHs in the Anacostia River sediments.

5.2.3 Investigation-Derived Waste (IDW) Management

IDW generated during the Landside and Waterside investigations include the following:

- Disposable material such as Geoprobe®/Vibracore™ liners, personal protective equipment (PPE), plastic sheeting, etc.
- Drill cuttings
- Excess soil/sediment leftover from sampling activities
- Well development water
- Purge water
- Decontamination water

Minimally-contaminated disposable sampling materials and PPE will be rinsed and disposed of as ordinary solid waste. Drill cuttings, soil and sediment will be containerized and sampled for RCRA waste characteristics and PCBs. These wastes will be managed as dictated by the waste characterization results and disposed of at properly permitted off-site disposal facilities. All water will be containerized, sampled and disposed of at a permitted off-site facility.

5.3 Data Evaluation and Validation

All laboratory analytical data will be provided by the supporting laboratories in electronic formats, both Portable Document Format (PDF) and electronic data deliverables (EDD). The PDF format deliverable will include both sample results and all quality control (QC) results in standardized CLP-like format, as well as all supporting raw data. The PDF report will be searchable (embedded text) and bookmarked to facilitate data review. The associated EDD will be provided in an EQuIS four-file format. AECOM's requirements and clarifying definitions and valid values file for the EQuIS four-file format will be provided to all supporting laboratories. Complete paginated data packages will contain the following minimum information:

- A narrative specific to the sample data group (SDG) addressing any difficulties encountered during sample analysis and a discussion of any exceedances in the laboratory quality control sample results;
- A cross-referenced table of field and laboratory identification numbers;
- Analytical and preparatory method references;
- Definition of any data flags or qualifiers used; a list of valid data flags and qualifiers for use in the EQuIS reporting format will be provided;
- A table of contents for the data package similar to the USEPA Complete Sample Delivery Group File (CSF) Audit Checklist;
- A chain-of-custody signed and dated by the laboratory to indicate sample receipt. The temperature of the cooler will be noted on the chain-of-custody. Copies of shipping air bills will also be provided;
- Results for each field sample, blank and QC sample in units appropriate to the method presented on Form 1s or equivalent; reporting limits will also be provided and any analyte which is not detected will be reported as less than the reporting limit.
- Dilution factors for each sample or analyte;
- Calibration data including raw data; initial calibration curve data such as linear regression statistics or average relative response factors and percent relative standard deviation; continuing calibration data such as relative response factors and percent difference data;
- Gas chromatography/mass spectrometry (GC/MS) and Inductively Coupled Plasma-Mass Spectrometry (ICPMS) tuning data;
- Internal standard data;
- Surrogate (system monitoring) data;
- Inductively Coupled Plasma (ICP) inter-element correction factors, linear range data, serial dilution data, and interference check sample results;
- Copies of laboratory notebook pages or preparation logs showing sample preparation documentation;
- Field sample results and raw data (chromatograms, ICP printouts, etc.) including dilution data;
- Laboratory QC data including method blank data, laboratory duplicate data reported as relative percent difference (RPD), laboratory control spike data, reported as percent recovery; MS/MSD data reported as percent recovery with RPD calculated; all associated raw data will also be provided;
- Copies of phone logs, faxes and e-mails associated with the sample set; and
- Any other data necessary to conclusively confirm the analytical results reported and the overall quality of the data.

The laboratory will retain a copy of the completed data package and all copies of laboratory results, laboratory notes, quality assurance/quality control (QA/QC) data, and chain-of-custody record for a period of 10 years unless a shorter retention period is agreed upon in writing. All raw data on magnetic media along with identifying information will be retained for the duration of the Consent Decree and for a minimum period of 6 years after its termination.

Upon receipt from the laboratory, hard copy data and EDDs will be checked for completeness. During the data analysis process, a variety of quality checks are performed to ensure data integrity. These checks include:

- Audits to ensure that laboratories reported all requested analyses;
- Checks that all analytes are consistently and correctly identified;
- Reviews to ensure that units of measurement are provided and are consistent;
- Reports to review sample definitions (depths, dates, locations); and
- Proofing manually entered data against the hard-copy original.

All data generated from activities under this work plan will be subjected to assessment of data quality and usability per methodology provided in the QAPP. This assessment will include limited or full validation in accordance with USEPA National Functional Guidelines. Data qualifiers consistent with USEPA guidelines will be applied to results in the database. Reconciliation with the project data quality objectives will be performed and results of this assessment will be included in the RI report. Factors to be considered in this assessment of field and laboratory data will include, but not necessarily be limited to, the following:

- Conformance to the field methodologies and standard operating procedures (SOPs) proposed in the Work Plan and QAPP;
- Conformance to the analytical methodologies provided in the QAPP;
- Adherence to proposed sampling strategy;
- Presence of elevated detection limits due to matrix interferences or contaminants present at high concentrations;
- Unusable data sets (qualified as “R”) based on data validation;
- Data sets identified as usable for limited purposes (qualified as “J”) based on data validation;
- Effect of qualifiers applied as a result of data review on the ability to implement the project decision rules; and
- Status of all issues requiring corrective action, as presented in the QA reports to management.

The effect of nonconformance (procedures or requirements) or noncompliant data on project objectives will be evaluated. Minor deviations from approved field and laboratory procedures and sampling approach will likely not affect the adequacy of the data as a whole in meeting the project objectives. The assessment will also entail the identification of any remaining data gaps and an assessment of the need to re-evaluate project decision rules. This assessment will be performed by the AECOM technical team, in conjunction with the AECOM Project QA Officer, and the results presented and discussed in detail in the final report.

5.3.1 Data Management

Due to the dynamic nature of this investigation, data management will be critical to the success of the assessment. Automation of data collection, transmission, and processing will be integral to the performance of the project.

5.3.2 Field Data Collection and Transmission

Each investigation point will be located using a global positioning system receiver with sub-two-meter accuracy. These data will be uploaded on a daily basis to the project database that is discussed below in **Section 5.3.4**. Based on accessibility, exterior locations will also be surveyed by a licensed surveyor, while locations in building interiors will be field-measured from known landmarks.

Field notes will be transmitted to the project team in a timely manner. Laboratory deliverables will be provided in a format ready for upload into the project database.

5.3.3 Data Review

Field notes will be reviewed against the laboratory chains-of-custody. Field notes and field forms will be reviewed by the field team leader for accuracy and completeness.

At the beginning of each day of field work, a summary of anticipated laboratory deliverables for the day will be prepared. At the end of each day, the project team will review the list of daily deliverables for completeness and evaluate analytical data against applicable regulatory criteria. Analytical data will be reviewed and validated as described in the QAPP.

5.3.4 Project Database

Field data, laboratory data, and geospatial data will be uploaded to and stored in the project database. Laboratory deliverables will be received in an AECOM-specified electronic format ready for upload to the EQuIS database, and the database will be used with a GIS to prepare figures for evaluation of impacts and data gaps, while the field program is ongoing.

5.4 Risk Analysis

The RI will include performance of a Human Health and Ecological Risk Assessments (ERA) using validated data obtained during the RI field investigation. The approaches for both the Human Health and the Ecological Risk Assessments are summarized in the following sections and presented in detail in **Appendices E** and **F,** respectively.

5.4.1 Human Health Risk Assessment

A baseline Human Health Risk Assessment (HHRA) will be conducted to evaluate potential human health risks at the Site using the four step paradigm as identified by the USEPA in the *Risk Assessment Guidance for Superfund, Volume I – Human Health Evaluation Manual* (USEPA, 1989a). The steps are:

- Data Evaluation and Hazard Identification;
- Dose-Response Assessment;
- Exposure Assessment; and
- Risk Characterization.

As discussed in **Section 3.1** above, direct or indirect exposure pathways on the Landside portion of the Site are determined to be incomplete or insignificant because:

- Access to the Landside portions of the Site is limited by perimeter fencing and tight 7 day/24 hour security;
- The presence of impervious surfaces preventing contact with surface soil;
- Contact with subsurface soil is restricted by HASP procedures to prevent or manage worker's exposure during excavation activities; and
- Groundwater is not used as a local source of drinking water.

These forms of controls are commonly employed and accepted by USEPA to prevent exposure. Pepco will evaluate the current exposure scenarios on the Landside portion of the Site to evaluate all potential pathways and receptors as part of the Risk Assessment. This evaluation will provide additional details on the effectiveness of the existing operational and institutional controls to identify potential exposure scenarios. If significant exposure is identified, the CSM will be updated and the evaluation will be expanded to include the exposure assessment and risk characterization steps.

The Site will continue to be used as a service center by Pepco for the foreseeable future, and Pepco has no plans to redevelop any portion of the Site. Pepco agrees that the exposure scenarios may change depending on the future Site use, if the Site were ever sold or redeveloped. Pepco will qualitatively evaluate the potential for exposure to site media under hypothetical future exposure scenarios for the Landside portion of the Site as part of the Risk Assessment**,** taking into account existing institutional controls. The outcome from this evaluation will be documented in the Remedial Investigation report for future site management decisions in the event of a proposed change of site use or ownership.

In the event that a chemical abnormality is detected (e.g. significant VOCs are detected) in the soil and groundwater at the land portion of the Site, then the Human Health Risk Assessment Work Plan (**Appendix E**) will be updated to include the resultant effects to any potentially affected exposure pathways.

The HHRA therefore will focus on potential human health exposures to Anacostia River surface water, sediments, and fish. Because contaminant migration pathways via overland flow through storm drains and groundwater discharges to the Anacostia River may be of concern, the HHRA also will include evaluation of groundwater (as it discharges to the surface water of the Anacostia River).

The HHRA work plan is organized into the following sections:

- Data Evaluation and Hazard Identification – presents the methods to be used in the data evaluation and hazard identification, including selection of COPCs that will be evaluated quantitatively in the risk assessment;
- Dose-Response Assessment – presents a discussion of the dose-response assessment process. The dose-response assessment evaluates the relationship between the magnitude of exposure (dose) and the potential for occurrence of specific health effects (response) for each COPC. Both potential carcinogenic and non-carcinogenic effects will be considered. The most current USEPA-verified dose-response values will be used when available;
- Exposure Assessment - presents a discussion of the exposure assessment process. The purpose of the exposure assessment is to provide a quantitative estimate of the magnitude and frequency of potential exposure to COPCs by a receptor. Potentially exposed individuals, and the pathways through which those individuals may be exposed to COPCs are identified based on the physical characteristics of the Study Area, as well as the current and reasonably foreseeable future uses of the Study Area. The extent of a receptor's exposure is estimated by constructing exposure scenarios that describe the potential pathways of exposure to COPCs and the activities and behaviors of individuals that might lead to contact with COPCs in the environment. For the Waterside, the following potentially complete exposure scenarios are identified as warranting evaluation:

- Worker – potential direct exposure to site-related COPCs in surface water and sediment while working along the banks of the Anacostia River adjacent to the Site;
- Recreational Receptor – potential direct exposure to site-related COPCs in surface water and sediment while wading or swimming in the Anacostia River adjacent to the Site;
- Recreational Angler – potential indirect (consumption) exposure to site-related COPCs that may have bio-accumulated into fish in the Anacostia River, and to COPCs in surface water and sediment while fishing in the river.

Despite the presence of an advisory warning against the consumption of certain species of fish from the Anacostia and Potomac Rivers, it will be assumed that a recreational angler visits the Anacostia River to fish and consumes his/her catch;

- Risk Characterization – presents a discussion of the risk characterization process and uncertainties associated with the risk assessment process. Risk characterization combines the results of the exposure assessment and the toxicity assessment to derive site-specific estimates of potentially carcinogenic and non-carcinogenic risks resulting from both current and reasonably foreseeable future potential human exposures to COPCs. The results of the risk characterization will be used to identify constituents of concern (COCs), which are the subset of those COPCs whose risks result in an exceedance of the target risk of 10^{-6} for potential carcinogens and a target Hazard Index of 1 for non-carcinogens (that act on the same target organ) (USEPA, 1990; 1991b);
- Uncertainty Evaluation – Within any of the steps of the risk assessment process described above, assumptions must be made due to a lack of absolute scientific knowledge. Some of the assumptions are supported by considerable scientific evidence, while others have less support. The assumptions that introduce the greatest amount of uncertainty in this risk evaluation will be discussed in the Risk Characterization section of the HHRA report. The potential contribution of background to Site-related risks will also be discussed; and
- Summary and Conclusions – discusses the summary and conclusions section of the baseline HHRA report.

5.4.2 Ecological Risk Assessment

The ecological risk assessment (ERA) will be conducted according to the general tiered approach and methodology provided by the USEPA (1997, 1998, and 2001) based on the validated results of the Waterside field investigation to evaluate the potential for ecological risks associated with exposure to environmental media within or along the Anacostia River adjacent to the Site. The results of the ERA will be used to help inform the need for any additional evaluation and/or remedial action at the Site, and the NRDA. The ERA will focus on the Waterside portion of the Site, and will include evaluation of groundwater (as it discharges to the surface water of the Anacostia River), surface water, and sediment.

The general tiered approach of the ERA includes three main components: Problem Formulation, Risk Analysis, and Risk Characterization. Problem Formulation involves defining the objectives of the ERA and formulating the plan for characterizing and analyzing risks based on available site-specific information on stressors. Through this process, the CSM (**Section 3**) is better defined and potential exposure pathways, ecological receptors, and risk assessment endpoints are identified.

The Risk Analysis phase involves the evaluation of data to characterize potential ecological exposures and effects. Exposure point concentrations (EPCs) will be estimated for each COPC for each medium (e.g., sediment, surface water) to represent the concentrations that ecological receptors such as fish and benthic invertebrates may encounter. EPCs will be compared to literature-derived toxicity thresholds for each receptor to evaluate potential risks of COPC exposure in each type of media. Potential exposure of higher trophic level wildlife receptors includes direct or indirect ingestion of surface water, sediment, and ingestion of food items containing COPCs. Dietary doses of COPCs will be estimated for each wildlife receptor using food web exposure models based on exposure assumption values (e.g., body weights, food and water ingestion rates, relative consumption of food items, foraging range, exposure duration, etc.) and evaluated by comparing to daily dietary dose toxicity reference values (TRVs).

For the Risk Characterization, the results of the risk analysis are interpreted to determine the significance of any risks predicted for each assessment endpoint. This evaluation is based on the nature and magnitude and spatial and temporal patterns of predicted effects. Comparisons to background or reference sites and evaluation of the potential for recovery are also included in this analysis. The Risk Characterization concludes with a summary of uncertainties associated with the risk assessment.

5.5 Remedial Investigation Report

Upon completion of field activities and receipt of the analytical data, a draft RI Report will be prepared for submittal to DDOE. The draft report will be submitted to DDOE within 120 days of the completion of field work as required by the Consent Decree. The report will include the following elements:

- Site description;
- Site history and previous investigations/remedial actions;
- Description of field activities;

- Results of field activities to determine physical characteristics (e.g., surface water hydrology, geology/hydrogeology, ecology, etc.);
- Nature and extent of contamination;
- Contaminant fate and transport;
- Results of the HHRA and ERA ;
- Findings and conclusions; and
- Recommendations.

A more detailed report outline is provided as **Appendix G**. Geologic logs, cross sections, aquifer test results, laboratory data, validation reports, and pertinent field data logs will be included as appendices.

The draft RI Report is subject to review and approval by DDOE. DDOE also may solicit comments from other regional and federal agencies. In addition, DDOE will make the draft RI Report available for public review by posting on DDOE's website for at least 30 days prior to approving the RI. Pepco will revise the draft RI Report as appropriate to address comments from DDOE, other regulatory agencies, and the public. Pepco will submit a final RI Report following regulatory review.

5.6 Feasibility Study

An FS will be conducted for the Study Area based on the results of the RI. The objectives of the FS are to (a) identify remediation requirements and establish cleanup levels as necessary to eliminate or prevent unacceptable risks to human health and the environment, and (b) identify, screen and evaluate potential remedial alternatives. Various steps involved in the FS process are described in the following paragraphs. An FS Work Plan Addendum will be submitted upon the evaluation of data obtained from the RI field activities.

5.6.1 Identification of Remediation Requirements and Establishment of RAOs

The FS will identify areas and volumes of media for which remediation is required either (a) to eliminate or control conditions in the Anacostia River posing an unacceptable risk to human health and the environment or (b) to prevent the migration of contaminant from the Site to the river that would cause or contribute to an unacceptable risk to human health or the environment. All calculations related to area and volume estimates will be documented in the FS Report. For the areas where a remediation requirement is identified, remedial action objectives (RAOs) and preliminary remedial goals (PRGs) will be developed in consultation with DDOE. The PRGs will be developed based on Site-specific risk factors. The FS Report will describe the rationale for any cleanup levels established.

5.6.2 Development and Screening of Remedial Alternatives

The FS will identify and screen a focused set of technologies that have the potential to achieve the RAOs. This step will follow USEPA presumptive remedy guidance and USEPA's *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (2005). The FS will develop general response actions (such as containment, treatment, excavation, pumping, institutional controls (e.g., deed restrictions), engineering controls (e.g., encapsulation), or other actions, singly or in combination) for each medium of interest (e.g., soil, sediment, surface water, groundwater) to achieve RAOs, and will identify and evaluate technologies applicable to each general response action to eliminate those that cannot be implemented at the Site. Consistent with USEPA guidance, the range of remedial options to be considered will include, at a minimum (a) alternatives in which treatment is used to reduce the toxicity, mobility or volume of contaminants, (b) alternatives that involve containment with little or no treatment, and (c) a no-action alternative. Screening of technologies will be based on effectiveness, implementability, and relative cost. Technologies retained after the screening process will be assembled into alternatives for each remediation area.

5.6.3 Treatability Studies

Treatability studies will be performed as necessary to assist in the detailed analysis of alternatives. Treatability studies are generally performed to determine the effectiveness of a technology in achieving the targeted cleanup levels, to obtain design parameters for a full-scale process, or to screen multiple process options of a particular technology. Treatability studies are important when technologies have not been sufficiently demonstrated or characterization data alone is insufficient to predict treatment performance or to estimate the size and cost of treatment units. Treatability studies can be conducted on a bench-scale in the laboratory or on a pilot-scale at the Site depending on the study objectives. The need for treatability studies will be determined once the initial screening of technologies is completed and sufficient data from the RI are available.

5.6.4 Detailed Analysis of Alternatives

A detailed analysis will be conducted for the alternatives that are retained after the screening analysis. This detailed analysis will consist of an individual evaluation of each alternative against the following evaluation criteria and a comparative evaluation of all options against the evaluation criteria with respect to one another:

- Overall protection of human health and the environment;
- Compliance with applicable regulations;
- Long-term effectiveness;

- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability;
- Cost;
- DDOE acceptance; and
- Community acceptance.

5.6.5 Feasibility Study Report

Upon completion of the detailed evaluation of alternatives, a draft FS Report will be prepared for submittal to DDOE. The report will (a) document the location and extent of media requiring remediation and describe the associated cleanup levels and RAOs, (b) describe the results of the identification and screening of alternatives, and the detailed evaluation of alternatives, and (c) identify a preferred alternative for remedial action.

5.6.6 Regulatory Review and Public Comment

The FS Report is subject to review and approval by DDOE. DDOE also may solicit comments from other regional and federal agencies. In addition, DDOE will make the draft FS Report available for public review by posting on DDOE's website for at least 30 days prior to approving the FS Report. The FS Report will be revised as appropriate to address comments from DDOE, other regulatory agencies, and the public.

Pepco will submit a final FS Report following regulatory review and public comment.

6 Natural Resources Damage Assessment

One of the objectives of the RI is to collect data necessary for a Natural Resource Damage Assessment (NRDA). The NRDA will focus on identifying potential injuries to natural resources and quantifying any identified injuries in terms of their spatial and temporal extent, including the approximate area of impacted natural resources, the amount of time the resources have been affected, and the time necessary to restore the resource to a baseline condition. Although the NRDA is not part of the RI/FS process, it is expected to be conducted in parallel with DDOE's evaluation of remedial requirements and alternatives following the completion of the RI/FS.

The NRDA will be conducted pursuant to a separate work plan to be prepared after the completion of the RI/FS. The following presents a general outline of the tasks to be conducted as part of the NRDA:

Task 1: Information Review – Available environmental data will be reviewed to evaluate potential injuries associated with the Site. The types of data may include the data collected to support the RI, specifically the HHRA and ERA, and any other publically available data on potential impacts to wetlands, benthic invertebrates, finfish, shellfish, and human users of the natural resources at the Site. It is anticipated that the findings of the HHRA and the ERA, specifically the identification of complete exposure pathways and effects-based screening of surface water and sediment, will help to determine the potential for natural resource injuries. In addition, this information, along with other available environmental data (e.g., other studies conducted on the Anacostia River), will help to define the baseline conditions that would be expected at the Site in the absence of injury.

Task 2: Field Data Collection – The NRDA will be an iterative process and the initial assessment will be based on the surface water and sediment data collected for the RI (i.e., no additional data collection is anticipated for the NRDA at this time). If additional data are required to complete the NRDA based upon the review of the data collected during the RI, a separate work plan for the additional data collection will be prepared at that time. These data may include, for example, laboratory toxicology studies to evaluate the injuries to fish and/or benthic receptors.

Task 3: Preliminary analysis of injury and compensatory restoration alternatives – This analysis will focus on evaluation of potential injuries and the identification of restoration alternatives to compensate for injury. Potential injuries to natural resources such as wetland marsh systems (present along the banks of the Site), benthic invertebrates, finfish and shellfish, and wildlife and to potential human users of the system will be evaluated. Natural resource services will be defined based on the human health and ecological CSM developed for the Site; for example, services may include production of benthic invertebrate prey resources to support a healthy fish community for upper trophic fish and wildlife and recreational anglers. Losses of those services will be estimated both spatially and temporally to quantify potential injuries at the Site.

Depending on the results of the analysis, the extent of injury will be estimated using established techniques; for example, a commonly used method is the Habitat Equivalency Analysis (HEA). HEA provides a means to evaluate injury relative to compensatory restoration alternatives, incorporating the time it takes for an injured area to recover to baseline and the time for a restoration project to fully develop. HEA relies on a natural resource service-to-service approach to damage assessment, and provides a quantitative means to balance units of lost habitat services with units of restoration project services (NOAA, 1995).

Task 4: NRDA Report – Following completion of the activities described in the above tasks, a NRDA report will be prepared.

7 Project Organization

The RI/FS activities will be performed principally by AECOM (or its subcontractors) on behalf of Pepco. The project will be overseen by the DDOE to ensure compliance with the Consent Decree requirements. The Pepco Project Manager will maintain regulatory interface with DDOE and the AECOM Project Manager will support the Pepco Project Manager as needed. The AECOM Project Manager may interface directly with DDOE on technical matters related to the project. Roles and contacts for various project personnel are summarized in **Table 7**. Responsibilities for key project personnel are described in the following paragraphs:

<u>Pepco Project Manager</u>

Ms. Fariba Mahvi will serve as the Pepco Project Manager. Ms. Mahvi's responsibilities include:

- Representing Pepco management,
- Reviewing AECOM's work;
- Primary interface with DDOE,
- Securing project funding,
- Working with Pepco Community Involvement Coordinator (Donna Cooper) to implement CIP, and
- Reviewing all project documents before submission to DDOE.

<u>AECOM Project Manager</u>

The AECOM Project Manager, Mr. Ravi Damera, has responsibility for day-to-day management of technical and scheduling matters related to the project. Other duties, as necessary, of the AECOM Project Manager include:

- Subcontractor procurement,
- Assignment of duties to project staff and orientation of the staff to the specific needs and requirements of the project,
- Ensuring that data assessment activities are conducted in accordance with the QAPP,
- Approval of project-specific procedures and internally prepared plans, drawings, and reports,

- Serving as the focus for coordination of all field and laboratory task activities, communications, reports, and technical reviews, and other support functions, and facilitating site activities with the technical requirements of the project, and
- Maintenance of the project files.

AECOM Technical Leaders

The AECOM Project Manager will be assisted by Technical Leads, whose duties will include:

- Ensuring data assessment activities are conducted in accordance with the QAPP,
- Serving as the focus for coordination of all field and laboratory task activities, communications, reports, and technical reviews, and other support functions, and facilitating site activities with the technical requirements of the project,
- Technical review and/or approval of project-specific procedures and internally prepared plans, drawings, and reports,
- Serving as the focus for coordination of all field and laboratory task activities, communications, reports, and technical reviews, and other support functions, and facilitating site activities with the technical requirements of the project, and
- Maintenance of the project files.

AECOM Project QA officer

The AECOM Project QA Officer, Mr. Gary Grinstead, has overall responsibility for quality assurance oversight. The AECOM Project QA Officer communicates directly to the AECOM Project Manager. Specific responsibilities of the AECOM Project QA Officer include:

- Preparing the QAPP,
- Reviewing and approving QA procedures, including any modifications to existing approved procedures,
- Ensuring that QA audits of the various phases of the project are conducted as required,
- Providing QA technical assistance to project staff, and
- Ensuring that data validation/data assessment is conducted in accordance with the QAPP.

AECOM Analytical Task Manager

The AECOM Project Chemist/Laboratory Coordinator, Mr. Robert Kennedy, will be responsible for managing the subcontractor laboratories, serving as the liaison between field, laboratory personnel, data validation and database teams and assessing the quality of the analytical data.

AECOM Health and Safety Officer

The AECOM Project Health and Safety Officer, Mr. Sean Liddy, will serve as a health and safety advisor to the Project Manager and AECOM staff including:

- Reviewing and approving Health and Safety Plans,
- Reviewing subcontractor safety records,
- Conducting safety audits,
- Recommending appropriate PPE to protect AECOM personnel from potential hazards, and
- Conducting accident investigations.

AECOM Field Team leader

The AECOM Field Team Leader, Mr. Scott Beatson, has overall responsibility for completion of all field activities in accordance with the QAPP and is the communication link between AECOM project management and the field team. Specific responsibilities of the AECOM Field Team Leader include:

- Coordinating activities at the Site,
- Assigning specific duties to field team members,
- Mobilizing and demobilizing of the field team and subcontractors to and from the Site,
- Directing the activities of subcontractors on site,
- Resolving any logistical problems that could potentially hinder field activities, such as equipment malfunctions or availability, personnel conflicts, or weather dependent working conditions,
- Implementing field QC including issuance and tracking of measurement and test equipment; the proper labeling, handling, storage, shipping, and chain-of-custody procedures used at the time of sampling; and control and collection of all field documentation, and
- Communicating any nonconformances or potential data quality issues to AECOM project management.

AECOM Field Staff

The field staff reports directly to the AECOM Field Team Leader, although the Field Team Leader in some cases will be conducting the duties of the field staff listed below. The responsibilities of the field team include:

- Collecting samples, conducting field measurements, and decontaminating equipment according to documented procedures stated in the QAPP,
- Ensuring that field instruments are properly operated, calibrated, and maintained, and that adequate documentation is kept for all instruments,
- Collecting the required QC samples and thoroughly documenting QC sample collection,
- Ensuring that field documentation and data are complete and accurate, and
- Documenting and communicating any nonconformance or potential data quality issues to the AECOM Field Team Leader.

<u>AECOM Subcontractors</u>

AECOM specialty subcontractors may include, but are not limited to, drilling, surveying, analytical laboratories, waste management, and equipment rentals. These subcontractors will work under the direct supervision of AECOM field staff to carry out specific scope requirements.

8 Schedule

The Consent Decree requires Pepco to initiate the remedial investigation field work within 30 days of DDOE's approval of the final Work Plans. A tentative project schedule has been prepared (**Figure 14**) showing the duration of various tasks that will be triggered by the approval of this work plan and associated SAP and HASP. The task durations correspond to the deadlines specified in the Consent Decree. This schedule will be revised with actual calendar dates upon the final approval of the work plans. The field work schedule will be reviewed periodically with DDOE during the field work period and revised as necessary.

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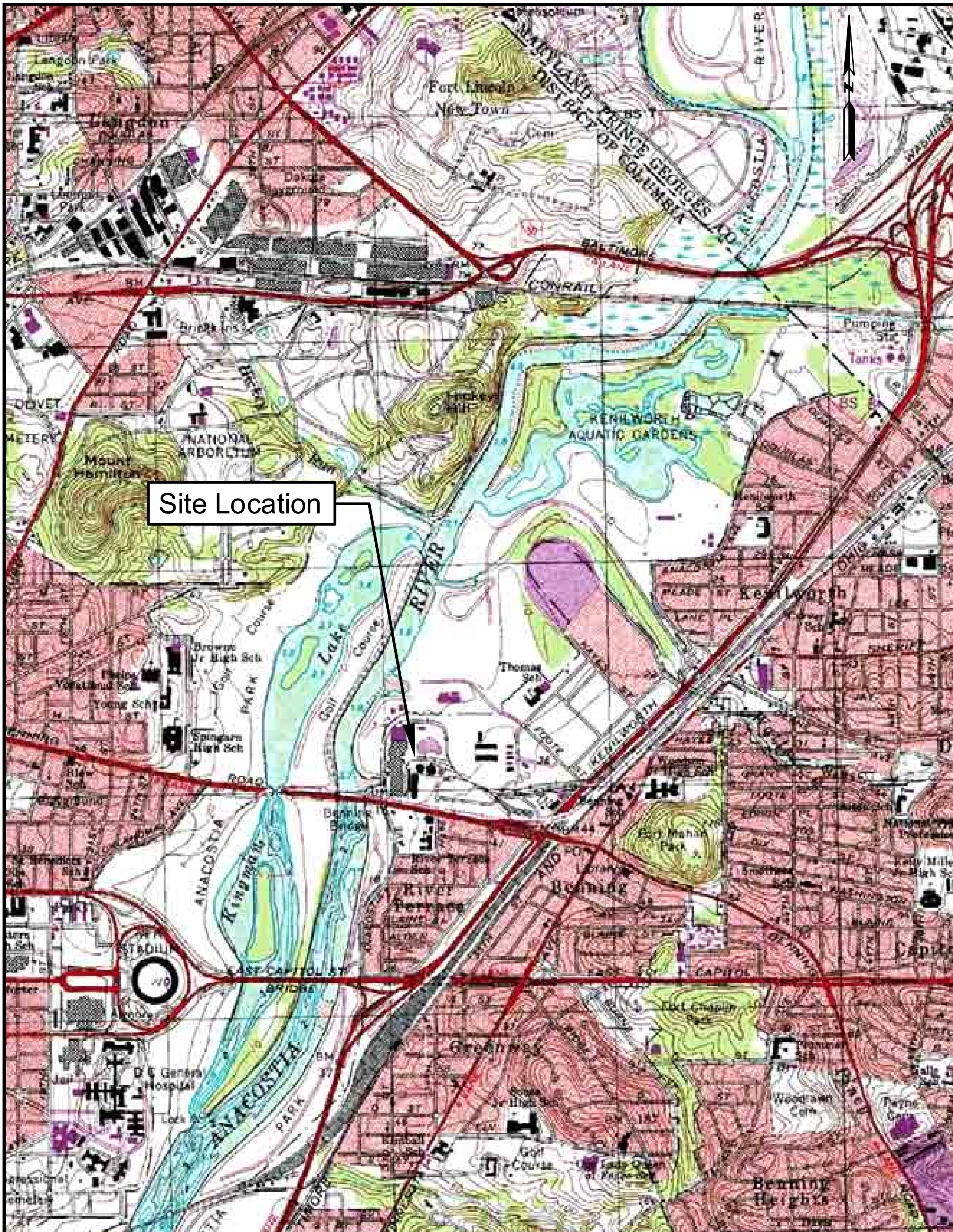
Figures



AECOM

Source:
USGS 7.5 Minute Topographic Map
Washington East Quadrangle

0 1000 2000 4000
SCALE IN FEET

Benning Road Facility RI/FS Project
3400 Benning Rd., NE
Washington, DC 20019

Site Location Map

DATE: 07/09/2012 | DRAWN BY: LAD | CHECKED BY: RD

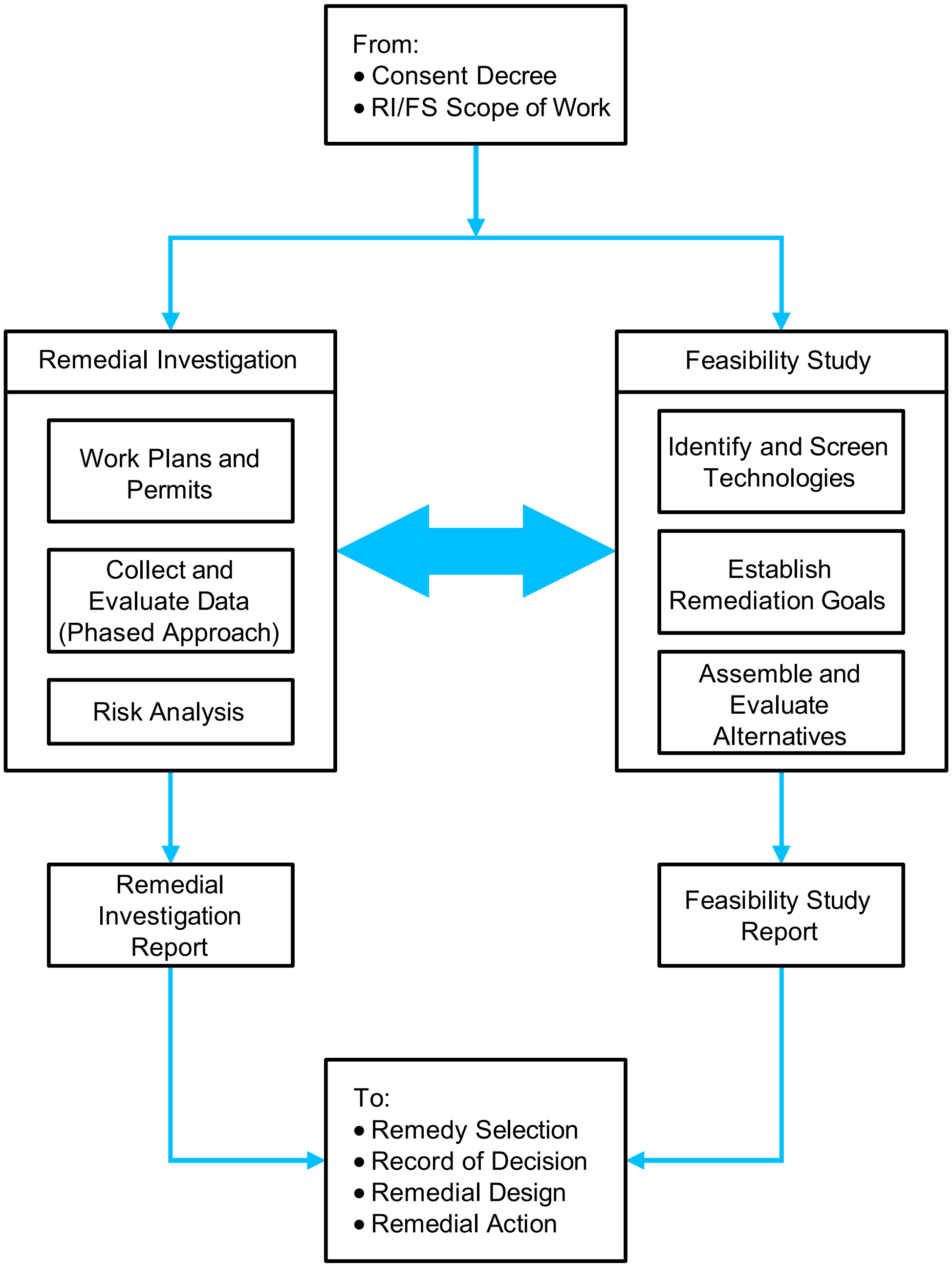
FIGURE 1

LEGEND:
- PROPOSED INVESTIGATION AREA
- BENNING ROAD FACILITY PROPERTY BOUNDARY
- PROPERTY BOUNDARY

0 100 200 400
SCALE IN FEET

AECOM

Benning Road Facility RI/FS Project 3400 Benning Rd., NE Washington, DC 20019			Site Plan And Investigation Areas
DATE: 06/20/2012	DRAWN BY: LAD	CHECKED BY: RD	FIGURE 2



AECOM

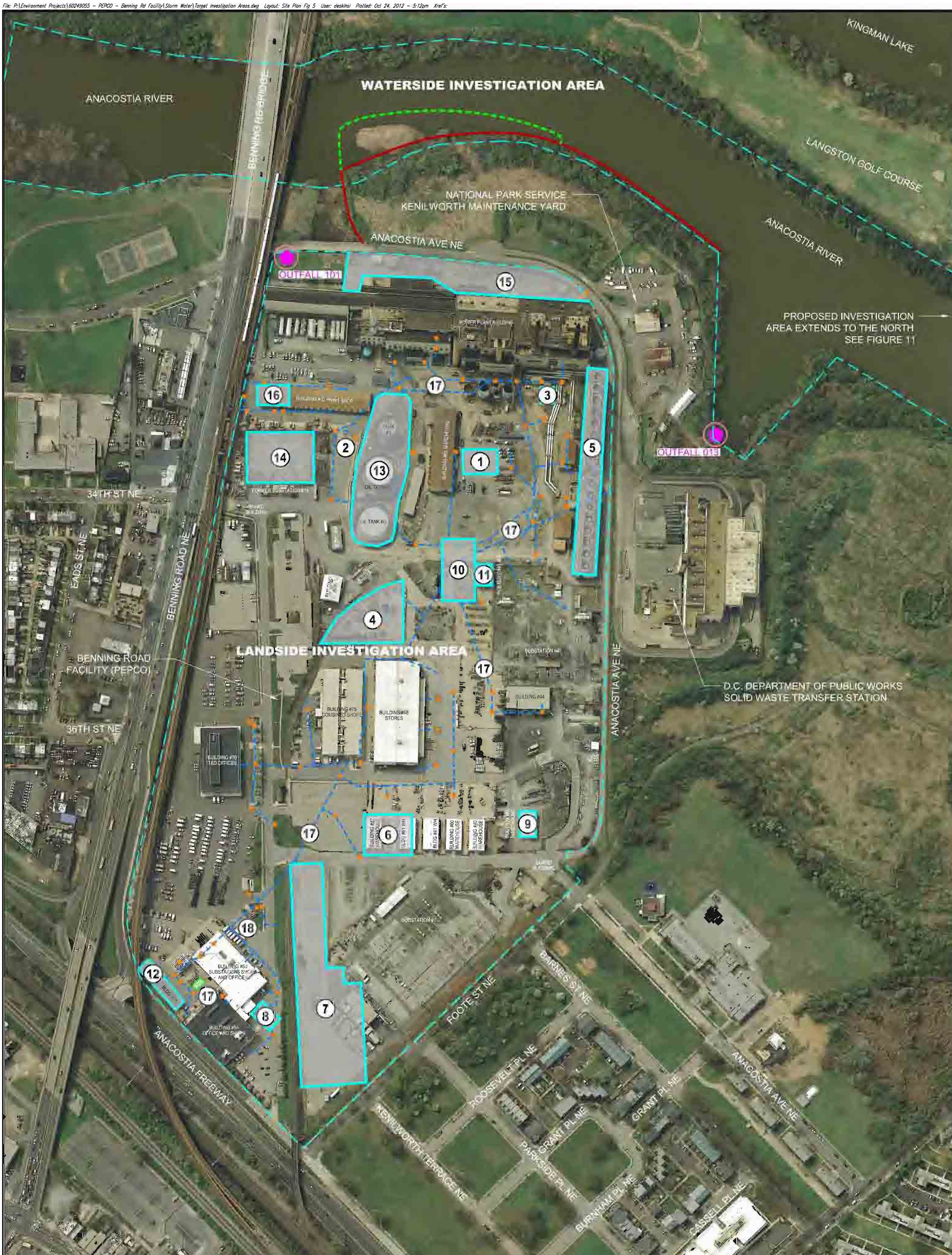
Benning Road Facility RI/FS Project 3400 Benning Rd., NE Washington, DC 20019	RI/FS Process
DATE: 07/09/2012 · DRAWN BY: LAD · CHECKED BY: RD	**FIGURE 3**

File: P:\Environment Projects\60249055 - PEPCO - Benning Rd Facility\RI-FS\Site Vicinity.dwg Layout: Layout1 User: deskinsl Plotted: Jul 16, 2012 - 4:20pm Xref's:

0 500 1000 2000
SCALE IN FEET

Benning Road Facility RI/FS Project 3400 Benning Rd., NE Washington, DC 20019	Site Vicinity Map
DATE: 07/16/2012 DRAWN BY: LAD CHECKED BY: RD	FIGURE 4

File: P:\Environment Projects\60249055 - PEPCO - Benning Rd Facility\Storm Water\Target Investigation Areas.dwg Layout: Site Plan Fig 5 User: deskinsi Plotted: Oct 24, 2012 - 5:12pm Xref's:



LEGEND:

- (18) TARGET AREA # - CORRESPONDS TO DESCRIPTION IN TABLE 2
- TARGET AREA
- NPDES OUTFALL TO ANACOSTIA RIVER
- INVESTIGATION AREA
- STORM WATER UTILITY
- APPROXIMATE FORMER CONSTRUCTED WETLANDS BOUNDARY
- APPROXIMATE LOCATION OF SEA WALL
- 15,000 GALLON NON-PCB NEW TRANSFORMER OIL UST

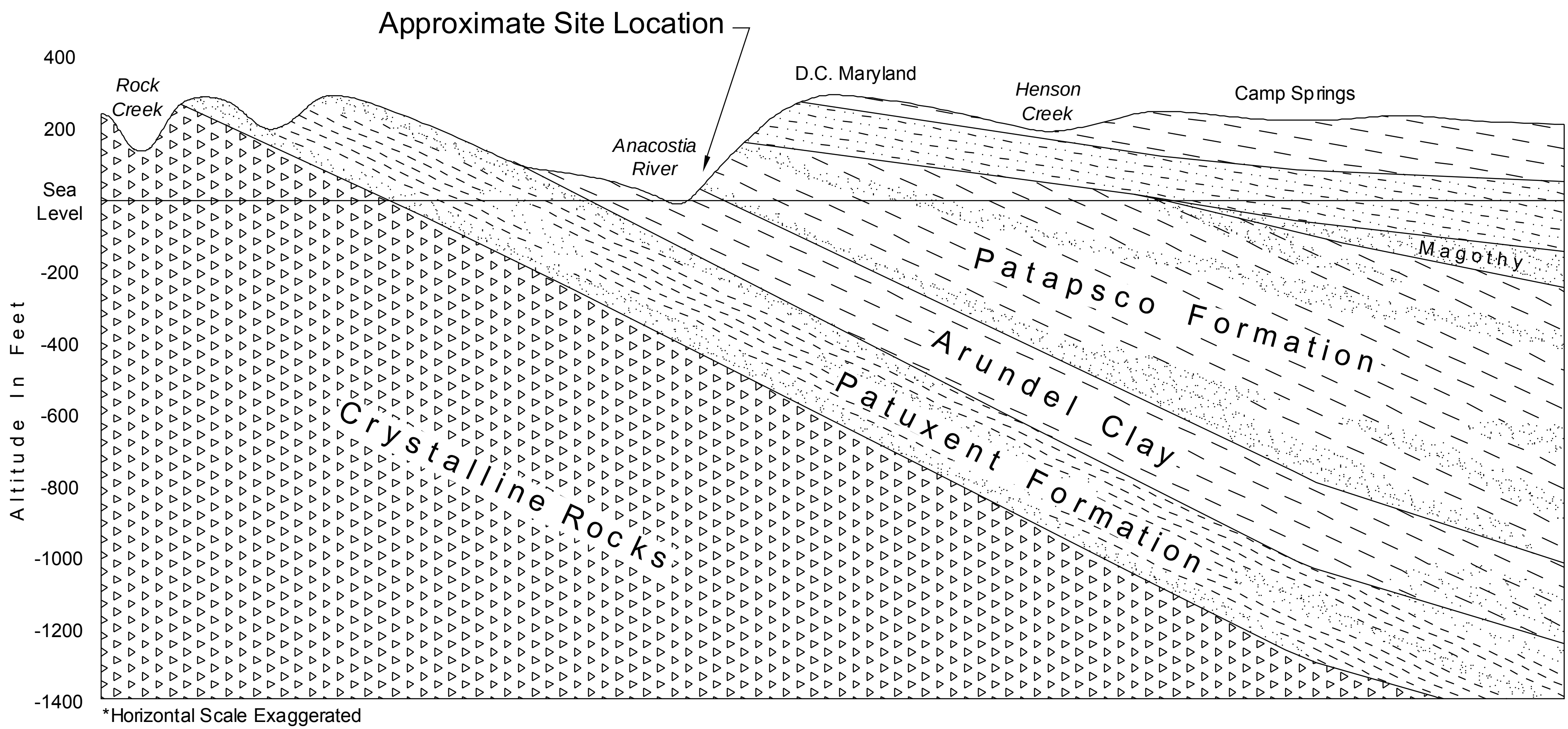
TARGET AREA KEY:

1. FORMER SLUDGE DEWATERING AREA
2. BENNING FUELING ISLAND
3. FORMER 15,000 GALLON No. 2 FUEL OIL UST
4. 2003 SALVAGE YARD INVESTIGATION
5. 1995 CLEANUP AREA
6. 1991 CLEANUP AREA
7. 1988 PARKING LOT CLEANUP AREA
8. 1985 EXCAVATION AREA
9. GREEN TAG STORAGE AREA
10. RED TAG STORAGE AREA
11. BUILDING #68 (PCB BUILDING)
12. BUILDING #57
13. BULK STORAGE ASTs WITH LOADING RACK 550 GALLON FUEL OIL UST AND 2,000 GALLON USED OIL UST
14. FORMER RAILROAD SWITCHYARD
15. GENERATING STATION TRANSFORMERS
16. PRINT SHOP
17. STORM DRAIN SYSTEM
18. KENILWORTH FUELING ISLAND

0 75 150 300
SCALE IN FEET

AECOM

Benning Road Facility RI/FS Project 3400 Benning Rd., NE Washington, DC 20019			**Target Investigation Areas**
DATE: 10/24/2012	DRAWN BY: LAD	CHECKED BY: RD	**FIGURE 5**



Source: Mack, KM. 1966.
Groundwater in Prince Georges County,
Bulletin 29: Maryland Geological Survey

AECOM

Benning Road Facility RI/FS Project 3400 Benning Rd., NE Washington, DC 20019			Regional Geologic Profile
DATE: 07/16/2012	DRAWN BY: LAD	CHECKED BY: RD	FIGURE 6

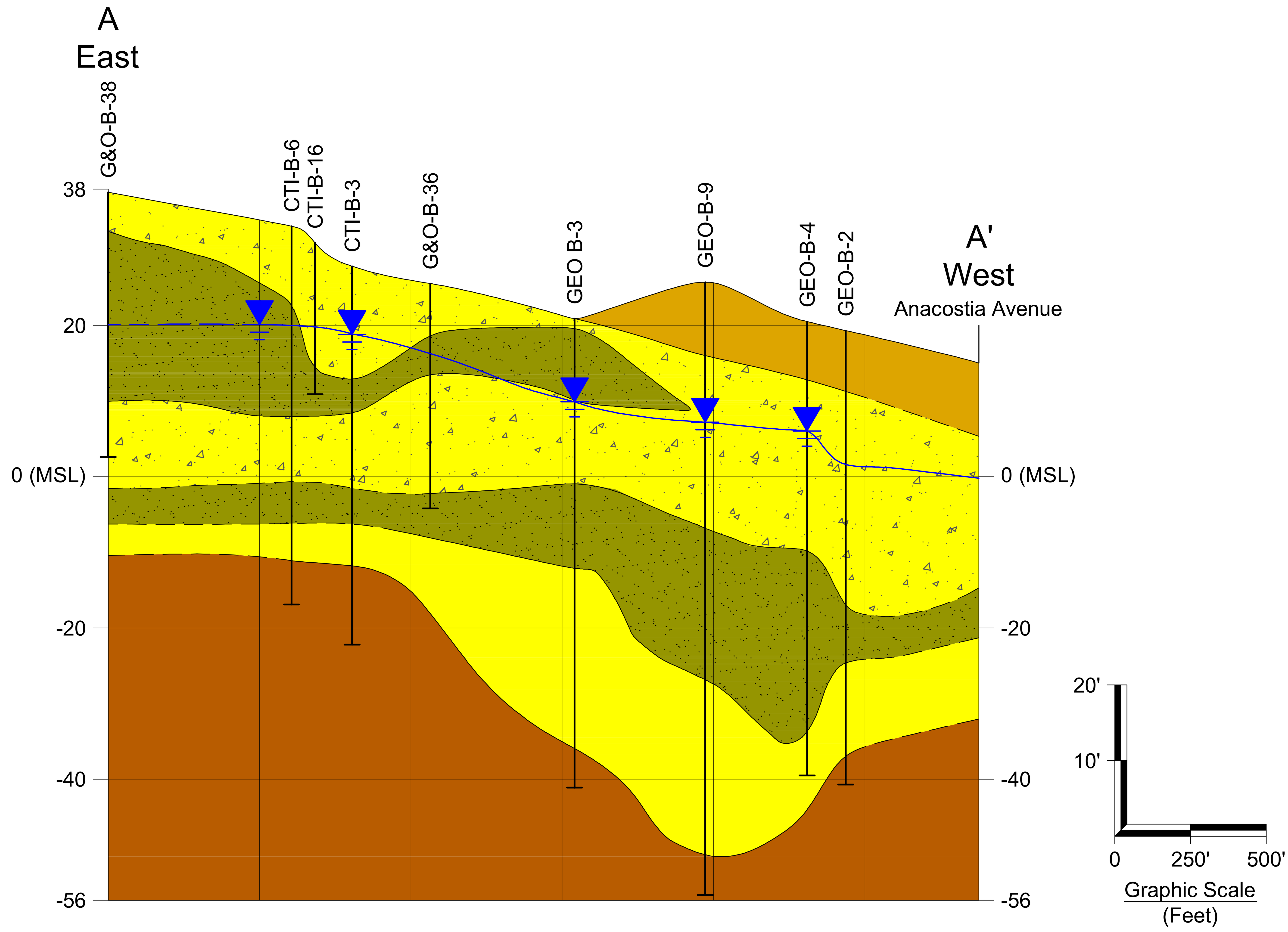
LEGEND:

- APPROXIMATE LOCATION OF SOIL BORING INSTALLED BY GEOMATRIX, INC. IN 1988
- APPROXIMATE LOCATION OF SOIL BORING INSTALLED BY CTI CONSULTANTS, INC. IN 2009
- APPROXIMATE LOCATION OF SOIL BORING INSTALLED BY GREENHOUSE & O'MARA, INC. IN 2009
- USGS SOIL BORING DCHP01 INSTALLED IN 2002
- PROPOSED SOIL BORING
- PROPOSED AREA FOR ONE (1) SOIL BORING ON NPS PROPERTY
- PROPOSED INVESTIGATION AREA
- BENNING ROAD FACILITY PROPERTY BOUNDARY
- PROPERTY BOUNDARY
- A — A' LINE OF CROSS-SECTION

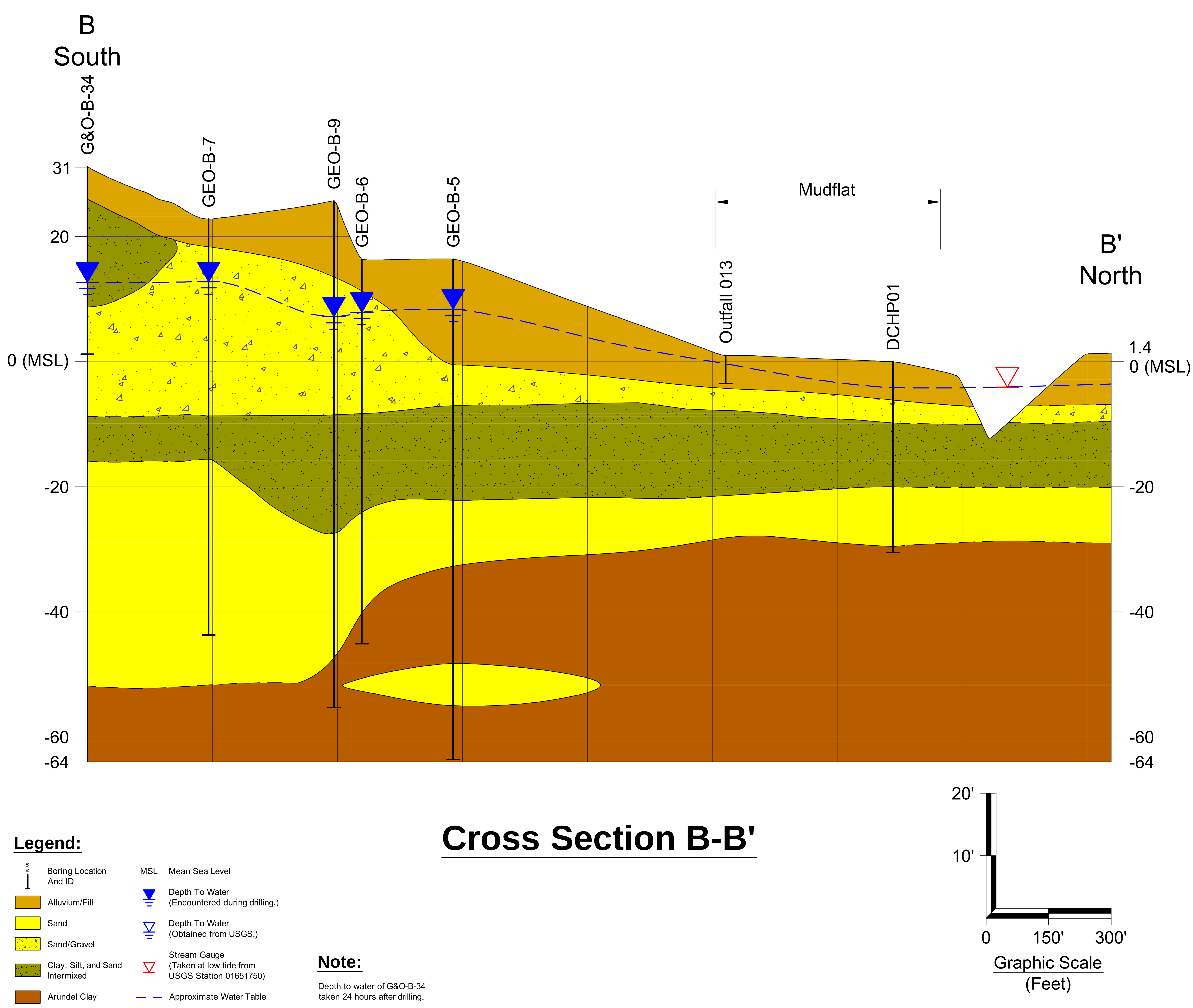
0 75 150 300
SCALE IN FEET

AECOM

Benning Road Facility RI/FS Project 3400 Benning Rd., NE Washington, DC 20019			HISTORICAL AND PROPOSED SOIL BORINGS
DATE: 07/16/2012	DRAWN BY: LAD	CHECKED BY: RD	FIGURE 7



Cross Section A-A'



Cross Section B-B'

Legend:

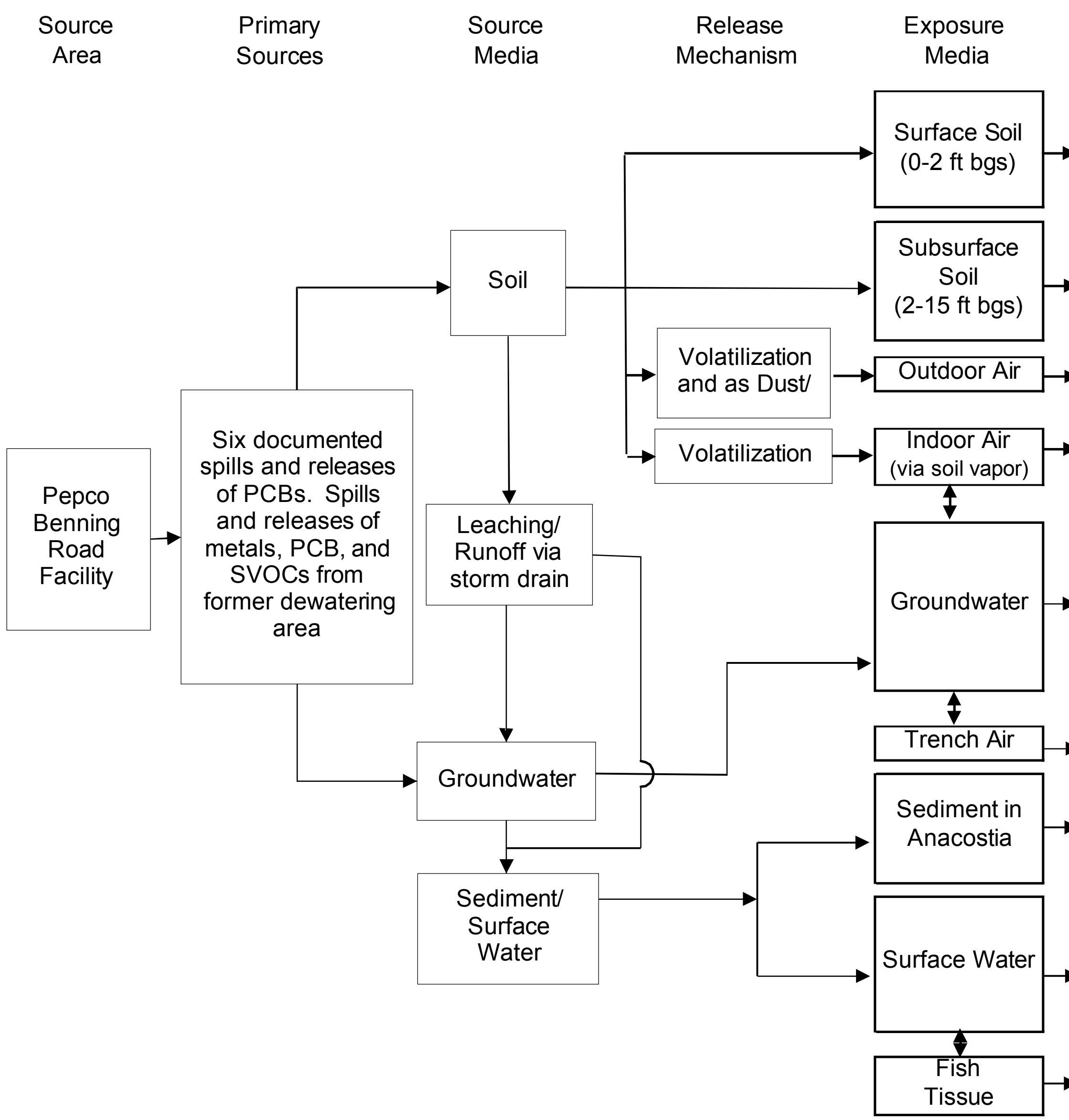
- Boring Location And ID
- Alluvium/Fill
- Sand
- Sand/Gravel
- Clay, Silt, and Sand Intermixed
- Arundel Clay
- Inferred Lithology
- MSL Mean Sea Level
- Depth To Water (Encountered during drilling.)
- Depth To Water (Obtained from USGS.)
- Stream Gauge (Taken at low tide from USGS Station 01651750)
- Approximate Water Table

Note:

Depth to water of G&O-B-34 taken 24 hours after drilling.

AECOM

Benning Road Facility RI/FS Project 3400 Benning Rd., NE Washington, DC 20019			Geologic Cross Sections
DATE: 10/19/2012	DRAWN BY: LAD	CHECKED BY: RD	FIGURE 8



Exposure Media	Potential Exposure Route	Current On-Site Worker	Current/ Future Construction Worker	Future Tresspasser	Future On-Site Worker	Hypothetical Future On-Site Resident	Terrestrial Plant Community	Soil Invertebrate Community	Benthic Invertebrate Community	Avian and Mammalian Communities
		Potential Human Receptors/Exposure Pathways					Potential Ecological Receptors/Exposure Pathways			
Surface Soil (0-2 ft bgs)	Incidental Ingestion	○	○	○	○	○	○	○	○	○
	Dermal / Direct Contact	○	○	○	○	○	○	○	○	○
Subsurface Soil (2-15 ft bgs)	Incidental Ingestion	○	○	○	○	○	○	○	○	○
	Dermal / Direct Contact	○	○	○	○	○	○	○	○	○
Outdoor Air	Inhalation	○	○	○	○	○	○	○	○	○
Indoor Air (via soil vapor)	Inhalation	○	○	○	○	○	○	○	○	○
Groundwater	Ingestion as Drinking Water	○	○	○	○	○	○	○	○	○
	Dermal / Direct Contact	●	●	○	●	○	○	○	○	○
	Incidental Ingestion	●	●	○	●	○	○	○	○	○
Trench Air	Inhalation	●	●	○	●	○	○	○	○	○
Sediment in Anacostia	Incidental Ingestion	○	○	●	○	●	○	○	●	●
	Dermal / Direct Contact	○	○	●	○	●	○	○	●	○
Surface Water	Incidental Ingestion	○	○	●	○	●	○	○	●	●
	Dermal / Direct Contact	○	○	●	○	●	○	○	●	○
Fish Tissue	Ingestion	○	○	●	○	●	○	○	○	●

Notes:
- ● Potentially complete pathway.
- ○ Pathway considered to be incomplete or insignificant.
- —— Potential release mechanism.
- ft bgs Feet below ground surface.

Preliminary Conceptual Site Model

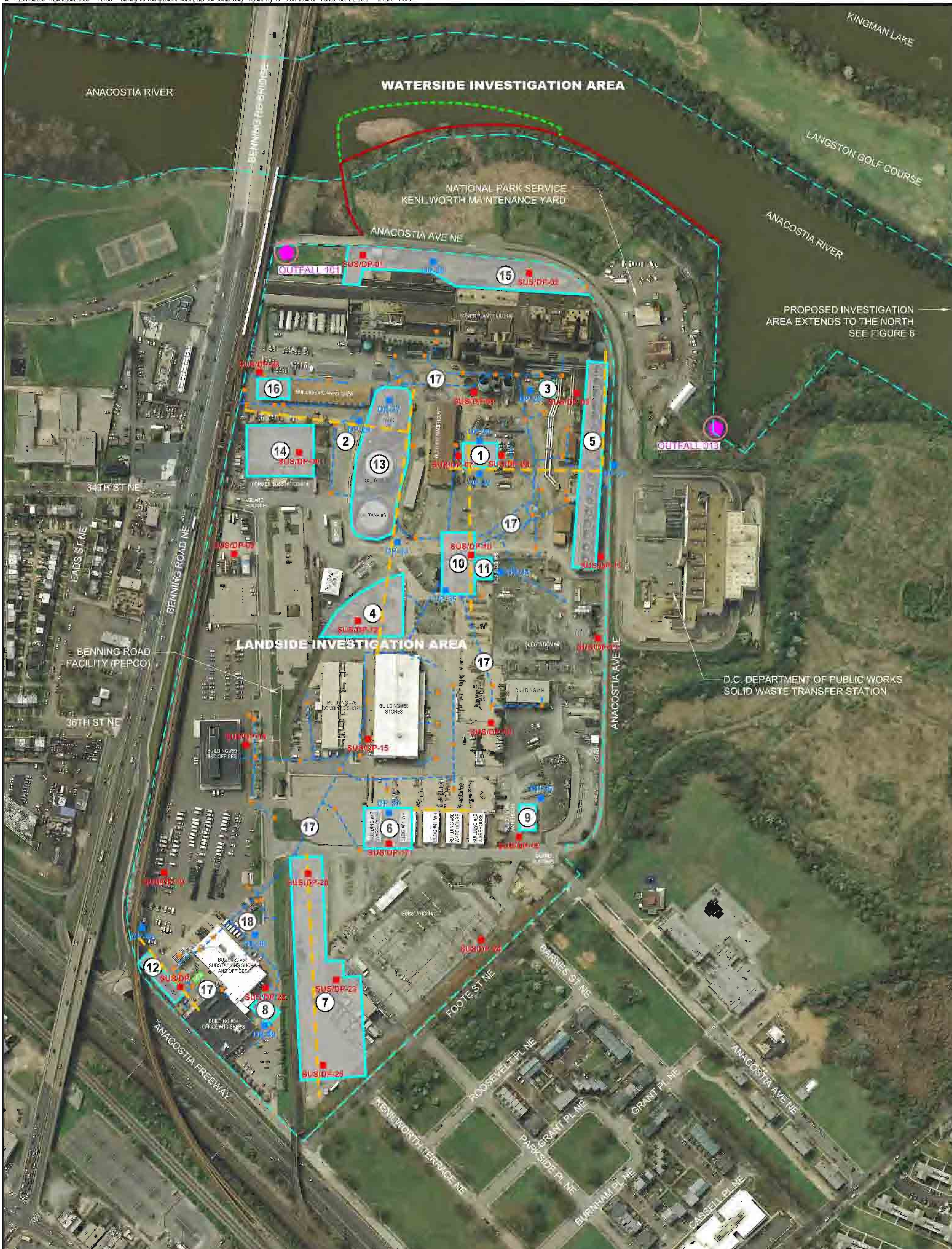
FIGURE 9

Benning Road Facility RI/FS Project
3400 Benning Rd., NE
Washington, DC 20019

DATE: 10/23/2012 DRAWN BY: LAD CHECKED BY: RD

AECOM

File: P:\Environment Projects\60249055 - PEPCO - Benning Rd Facility\Storm Water\Prop Soil Samples.dwg Layout: Fig 10 User: deskins Plotted: Oct 24, 2012 - 5:14am Xref's:



LEGEND:

- SUS/DP-01 — PROPOSED SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION
- DP-26 — PROPOSED DIRECT PUSH SAMPLE LOCATION
- POTENTIAL ELECTRICAL RESISTIVE IMAGING (ERI) TRANSECT
- (18) — TARGET AREA # - CORRESPONDS TO DESCRIPTION IN TABLE 2
- TARGET AREA
- NPDES OUTFALL TO ANACOSTIA RIVER
- INVESTIGATION AREA
- STORM WATER UTILITY
- APPROXIMATE FORMER CONSTRUCTED WETLANDS BOUNDARY
- APPROXIMATE LOCATION OF SEA WALL
- 15,000 GALLON TRANSFORMER OIL UST

TARGET AREA KEY:

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12. BUILDING #57
13. BULK STORAGE ASTs WITH LOADING RACK 550 GALLON FUEL OIL UST AND 2,000 GALLON USED OIL UST
14. FORMER RAILROAD SWITCHYARD
15. GENERATING STATION TRANSFORMERS
16. PRINT SHOP
17. STORM DRAIN SYSTEM
18. KENILWORTH FUELING ISLAND

0 75 150 300
SCALE IN FEET

NOTE:
PROPOSED SAMPLE LOCATIONS MAY CHANGE BASED ON RESULTS OF PHASE I ACTIVITIES.

AECOM

Benning Road Facility RI/FS Project
3400 Benning Rd., NE
Washington, DC 20019

Proposed Soil Sample and ERI Transect Locations

DATE: 10/24/2012	DRAWN BY: LAD	CHECKED BY: RD	FIGURE 10

LEGEND:

- ▲ TENTATIVE STORM DRAIN SAMPLING LOCATIONS
- PEPR1 1997 SEDIMENT/RESIDUE SAMPLE LOCATION ID
- APPROXIMATE FORMER CONSTRUCTED WETLANDS BOUNDARY
- APPROXIMATE LOCATION OF SEA WALL

SOURCE:
AMEC DRAINAGE AREA MAP, 11/21/11

NOT TO SCALE

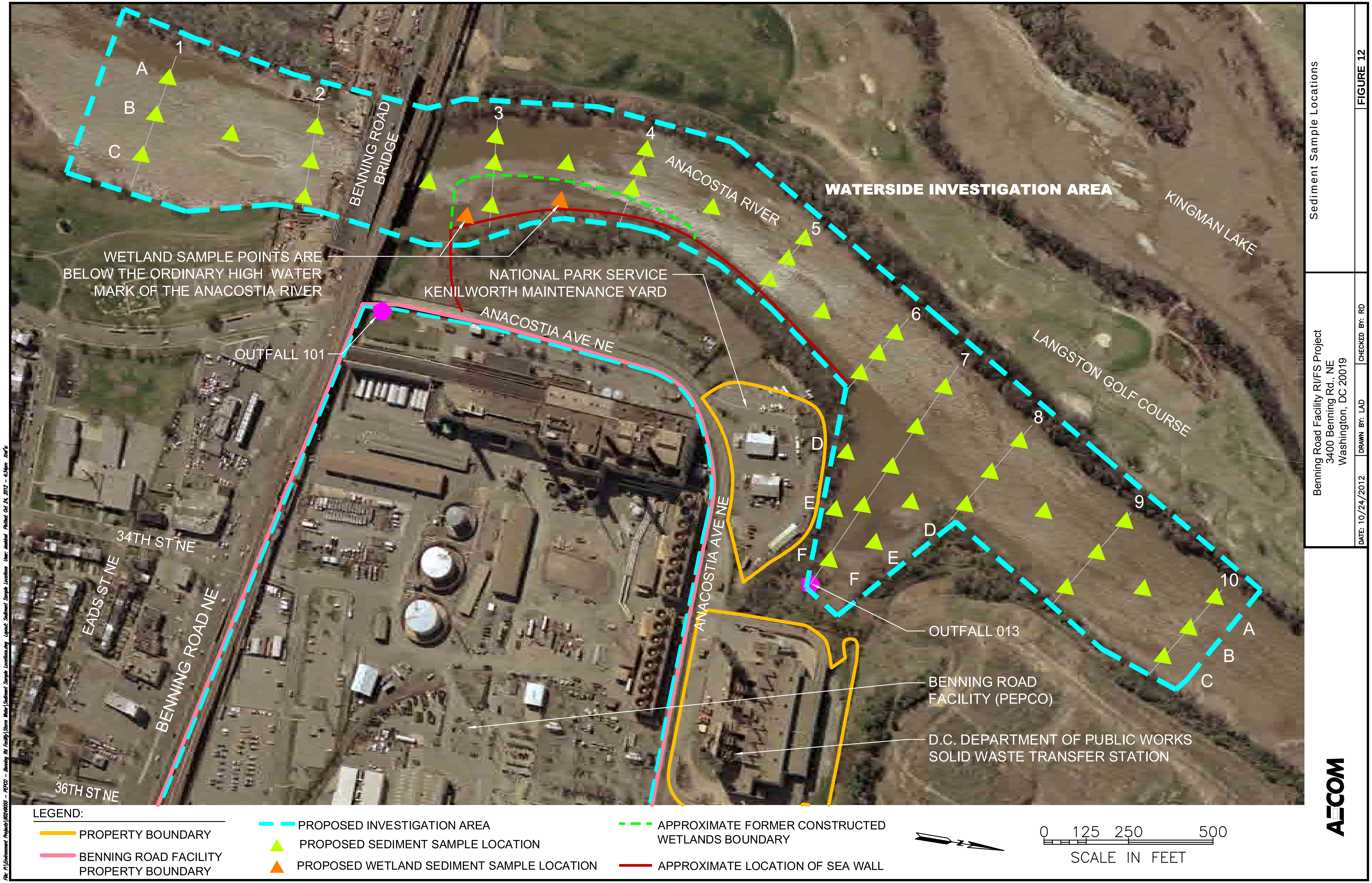
FIGURE 11

Proposed Sediment/Residue Sample Location Map

Benning Road Facility RI/FS Project
3400 Benning Rd., NE
Washington, DC 20019

DATE: 10/24/2012 | DRAWN BY: LAD | CHECKED BY: RD

AECOM


WATERSIDE INVESTIGATION AREA
ANACOSTIA RIVER
KINGMAN LAKE
LANGSTON GOLF COURSE
BENNING ROAD BRIDGE
WETLAND SAMPLE POINTS ARE BELOW THE ORDINARY HIGH WATER MARK OF THE ANACOSTIA RIVER
NATIONAL PARK SERVICE KENILWORTH MAINTENANCE YARD
ANACOSTIA AVE NE
OUTFALL 101
OUTFALL 013
34TH ST NE
EADS ST NE
BENNING ROAD NE
36TH ST NE
BENNING ROAD FACILITY (PEPCO)
D.C. DEPARTMENT OF PUBLIC WORKS SOLID WASTE TRANSFER STATION
1
2
3
4
5
6
7
8
9
10
A
B
C
D
E
F
LEGEND:
PROPERTY BOUNDARY
BENNING ROAD FACILITY PROPERTY BOUNDARY
PROPOSED INVESTIGATION AREA
PROPOSED SEDIMENT SAMPLE LOCATION
PROPOSED WETLAND SEDIMENT SAMPLE LOCATION
APPROXIMATE FORMER CONSTRUCTED WETLANDS BOUNDARY
APPROXIMATE LOCATION OF SEA WALL
0 125 250 500
SCALE IN FEET
Sediment Sample Locations
FIGURE 12
Benning Road Facility RI/FS Project
3400 Benning Rd., NE
Washington, DC 20019
DATE: 10/24/2012
DRAWN BY: LAD
CHECKED BY: RD
AECOM

N
W E
S

Potential Background Sampling Locations
Pepco – Benning Road Facility
Washington, DC

0 0.5 1 2 Miles

Data presented has been queried from the NOAA Query Manager Database and may include data from the following studies:
1980-92 VA State Water Control Board
1981-82 MD OEP Water Monitoring Data
1986-99 NSWC White Oak Env. GIS Layer
1989 ICPRB/Limno-Tech Sediment Survey
1990 EMAP - Chesapeake Bay
1991 EMAP - Chesapeake Bay
1992 Bolling AFB - SW Corner
1992 Potomac & Anacostia Sediment Study
1993 EMAP - Chesapeake Bay
1993 FWS Kennilworth Marsh
1995 PEPCO
1995 Washington Navy Yard
1996 PWS PAH/PCB - Mason Neck
1996 WA Gas - East Station Project
1996 Wetland Restoration - Kennilworth
1997 DC Sediment Core Analysis
1998 BARC RI
1998 USACE Federal Nav Channel
1999 AWTA Sediment Quality Triad
1999 GSA SE Federal Center
1999 WA Navy Yard RI
2000 ANS Sediment Study
2000 Ambient Tox Chesapeake Bay
2000 USFWS Bioavailability
2003 Active Capping Site Char Rpt
2009 Final Site Investigation Report

Benning Road
Waterside Investigation Area
Property Boundaries
Riverine Boundary

Proposed Sampling Location
Historic Sampling Location
Potential Background Sampling Location

AECOM

Figure 13

Figure 14
Benning Road RI/FS Project Timeline
Pepco Benning Road Site
3400 Benning Road, NE, Washington DC

Action Number	Action/Event	Duration (days)	Total Timeline from Work Plan Approval (days)	Notes
1	Approval of RI/FS WP (including HSP, FSP, QAPP, and CSM) by DDOE	0	0	
2	Obtain Permits (NPS, USACE, DCRA/DDOE)	30	30	Concurrent with Action Item 3
3	Begin RI Field Work	30	30	Per CD, not more than 30 days after the final RI/FS WP approval
4	Complete RI Field Work	120	150	
5	**Pepco's Submission of Draft RI Report**	**120**	**270**	**Not more than 120 days after completion of RI field work**
6	**Pepco's Submission of Draft FS Report**	**180**	**330**	**Not more than 180 days after completion of RI field work (or 120 days after approval of treatability study report, if required)**

Notes:

1. **Bold faced-entries indicate activities that will trigger request for public comment.**
2. **Dates are subject to change as project planning and implementation progresses. This document will be updated periodically as necessary.**
3. **RI Field Work duration does not include any delays due to weather, additional work plan approvals and permits.**

Acronyms:

CD - Consent Decree
CSM - Conceptual Site Model
FS - Feasibility Study
FSP - Field Sampling Plan
HSP - Health and Safety Plan
QAPP - Quality Assurance Project Plan
RI - Remedial Investigation
WP - Work Plan

Tables

Table 1
Historical Removal Actions and Investigations
Benning Road Facility RI/FS Project
3400 Benning Road, NE
Washington, DC 20019

Date	Incident / Investigation	Location	TA #	Activities
May-85	**PCB Cleanup**: Underground pipe leaked waste transformer oil containing PCBs.	Underground pipe leading from Kenilworth Transformer Shop (Current Building 56)	8	Removal of aboveground storage tank, associated piping, and excavation of PCB-contaminated material >5 ppm (approximately 288 cu ft)
Sep-88	**PCB Cleanup**: Soil contamination detected under concrete pad used to prepare off-line PCB capacitor banks for disposal in area formerly used to store used electrical equipment.	Parking lot located in the northeast portion of facility.	7	Removal of approximately 2500 cu ft (389 tons) of PCB-contaminated material (>5 ppm), including concrete slab.
1989-97	**UST Removals**: A total of 6 USTs were removed/closed in place during this period	550-gal fuel oil (south of bulk tank #1)	13	All UST removals were inspected and approved for closure by the District.
		4,000-gal diesel (fuel island)	2	
		15K-gal fuel oil (east of Units 13 and 14)	3	
		2,000-gal used oil (Fleet Main.)	13	
		250-gal fuel oil	13	
		10K-gal Diesel (Fuel Island)	2	
Mar-91	**PCB Cleanup**: PCB capacitor leaked approximately 8 pounds onto concrete surface and seeped through expansion joints.	Concrete covered area located between Buildings 42 and 61	6	Approximately 126 cu ft PCB contaminated soil (>25 ppm PCBs) were removed and backfilled. Concrete replaced.
Apr-95	**PCB Cleanup**: PCB containing caulk and joint filler located inside cooling tower structures were found to be impacting the cooling tower concrete basins, sludge and water inside the basins, and soil adjacent to the basin's wall expansion joints. Pre-cleanup sediment sampling results from cooling tower blowdown discharge location upstream of Outfall 013 indicated no PCBs above 1 ppm.	Unit 15 and 16 cooling tower basins and surrounding soil	5	Approximately 185 cu ft of soil (>1-3 ppm) PCB was excavated. Old joint filler and caulk were removed and the expansion joints and basin were double washed and rinsed. The basin was encapsulated with concrete sealant after all rinse water was removed.
Sep-96 to Mar-97	**Intake Dredging**: Dredging of Station Intake for creation of wetlands	Generating station intake and points up- and downstream	*	Intake area in the Anacostia River was dredged and the dredge spoils were used to construct wetlands. Pre- and post-dredge sediment samples exhibited total PCBs of 119-934 ppb.
Apr-97	**USEPA Multi-media Inspection**: NPDES, RCRA and TSCA compliance inspection conducted by USEPA.	Entire facility	17	No compliance problems noted. PCBs at 0.25-3.13 ppm detected in residue samples from storm sewers inlets and outfalls. Elevated concentrations of heavy metals were also detected.
Dec-99	**Phase I Environmental Site Assessment**: conducted by PHI in anticipation of property transaction.	Entire facility	13	Recognized environmental concerns noted oil staining at two #4 and #2 fuel oil recirculation ASTs located east of the generating station. No concrete bottom noted in the containment areas.
Nov-03	**Salvage Yard Investigation**: Soil investigation was completed in area formerly used for storing used electrical equipment.	Salvage yard located west of Buildings 75 and 88	4	Approximately 296 cu ft of PCB contaminated material (>1 ppm) was removed from the site. TPH-DRO was detected, but were below DCDOH requirements upon final excavation.
Jun-09	**USEPA Site Inspection**: Site Inspection conducted during 2008 to determine further actions under CERCLA.	Former sludge dewatering area and the Anacostia River water and sediments	1	Metals, PAHs and PCBs were detected in the former sludge dewatering area and in Anacostia River sediments at concentrations exceeding the screening levels. USEPA links the historical discharges at the site to contamination found in river sediments.
Jan-10	**Phase I ESA**: conducted in connection with substation expansion.	18.5-acre area in the eastern and southern portions of the site that will be impacted by the substation expansion.	--	Conclusions noted potential for petroleum, metals and PCB impacts of subsurface soils and recommended sampling to develop proper health and safety and soils management procedures during construction.

Notes:
TA - Target Area as identified in Table 2 and on Figure 5.
* Area identified as waterside investigation area.

Table 2
Target Areas
Benning Road Road Facility RI/FS Project
3400 Benning Road, NE
Washington, DC 20019

TA #	Name	Location	Comments	Target Constituents
1	Former Sludge Dewatering Area	Between Building 65 and Cooling Towers	Area exists in the former coal yard and was used as a decanting area for boiler fireside wash down for river sediment sludge from the clarifiers. In September 2008, TetraTech completed sampling to a depth of 1 ft bgs as part of a Site Inspection for USEPA. (USEPA, 2009; referred to as "USEPA SI Report")	PAHs, PCBs,metals
2	Benning Fueling Island	Located east of Building # 32	A 20,000 gallon gasoline UST and a 20,000 gallon diesel UST currently hold fuel for fleet vehicles at the Benning Fueling Island. These tanks are provided with leak detection monitoring systems. According to the 1999 URS Phase I ESA, there have been no tank tightness failures. A 4,000 gallon diesel UST was removed in this area in 1991. Soil was found to be impacted and was removed. A 10,000 gallon diesel UST was removed in June 1991. Soil was found to be impacted and was removed. Both UST cases were closed with the District approval. (URS, 1999)	TPH-GRO/DRO
3	Former 15,000 Gallon Number 2 Fuel Oil UST	East of Generating Station building near units 13 and 14.	The UST was removed in 1989 and confirmatory samples showed TPH levels in excess of 100 mg/kg. A 20 ft by 20 ft area was excavated to 15 ft bgs where groundwater was encountered. An oil sheen was noted on the water table and the oil/water mixture was pumped out to the plant oil/water separator. The excavation was backfilled and a recovery well installed to recover any residual oil. DC DDOE considered this case closed in a February 1992 letter. (URS, 1999)	TPH - DRO
4	2003 Salvage Yard Investigation	Salvage yard located west of Buildings # 75 and # 88	Soil investigation and soil removal were completed in area formerly used for storing used electrical equipment. Jacques Whitford Company completed soil sampling down to a maximum depth of 5 feet. (Jacques Whitford Company, 2003)	Metals, TPH-GRO/DRO,PCBs
5	1995 Cleanup Area	Unit 15 and 16 cooling tower basins and surrounding soil	PCB containing caulk and joint filler located inside cooling tower structures were found to be impacting the cooling tower concrete basins, sludge and water inside the basins, and soil adjacent to the basin's wall expansion joints. Pre-cleanup sediment sampling results from cooling tower blowdown discharge location upstream of Outfall 013 indicated no PCBs above 1 ppm. (Pepco, 1995)	TPH, PCBs
6	1991 Cleanup Area	Between Buildings # 42 and # 61	PCB capacitor leaked approximately 8 pounds onto concrete surface and seeped through expansion joints.1991 report stated that there were multiple excavations and that PCB concentrations were not detected. (Pepco, 1991)	TPH, PCBs
7	1988 Parking Lot Cleanup Area	Parking lot located in the eastern portion of facility.	Soil contamination detected under concrete pad used to prepare off-line PCB capacitor banks for disposal in area formerly used to store used electrical equipment. The concrete pad was demolished and disposed followed by removal of soil to a depth of 12 inches below grade. The cleanup was performed and 19 truckloads of PCB impacted materials were disposed of at a Waste Management facility located in Model City, New York. (Pepco, 1988)	TPH,PCBs
8	1985 Excavation Area	Underground pipe leading from Kenilworth Transformer Shop (Current Building # 56)	Underground pipe leaked waste transformer oil containing PCBs. (Pepco, 1985)	TPH, PCBs
9	Green Tag Storage Area	Storage Building #66	Building utilized for temporary storage of drums containing sludge removed from manholes while they await analysis for PCB content. An area located outside and in front of building 66 is used to store empty transformer casings that were previously identified as non-PCB. At the time of the EPA inspection, all of the casings were marked with a green tag that indicated they were less than 50 mg/kg PCB. (USEPA, 1997).	TPH, PCBs
10	Red Tag Storage Area	South of Building # 68 (PCB Storage Building)	The area is concrete and used for storage of empty transformer casings which had previously been identified with red tags as PCB contaminated (50 to 499 mg/kg). The casings are stored in this area until they are shipped off site for recycling. The EPA inspector noted no indications of spills or leaks in the area around the casings. (USEPA, 1997)	TPH, PCBs
11	Building #68 (PCB Building)	Building #68	Building used for storage of PCBs and hazardous waste in drums. The floor is concrete with a continuous concrete curb one foot high providing containment for 22,443 gallons. There were no leaks observed by the EPA inspector on or around the containers. Additionally, no staining was observed by the EPA inspector in Building 68. (USEPA, 1997)	PAHs, PCBs, TPH-GRO/DRO, metals
12	Building #57	Building #57	Building houses two 10,000 gallon holding tanks for accumulating waste oil. All waste oil with a PCB concentration of less than 49 mg/kg is pumped to these tanks. Both tanks are located in a large concrete vault inside of the building. These tanks are reportedly inspected daily by Pepco personnel. Currently, accumulated oil is taken to a permitted off-site facility for disposal/recycling. In the past, oil was transported to Pepco's Morgantown Generating plant to be burned in their boilers. At the time of the EPA inspection, oil stains were observed on the outside of tank 1 and on the concrete floor in the vault area. A concrete sump located in the back corner of the vault area was also observed to be full of oil. The loading area is located on the ground level of the building just above the storage tank area. The loading area slopes downward from the front and drains back into the tanks via a drain. No cracks were observed in the concrete loading ramp. (USEPA, 1997)	TPH-DRO, PCBs

Table 2
Target Areas
Benning Road Road Facility RI/FS Project
3400 Benning Road, NE
Washington, DC 20019

TA #	Name	Location	Comments	Target Constituents
13	Bulk Storage ASTs and Loading Rack	East of the Generating Station Building	3 AST's located within dikes and on a clay floor with initial construction dates ranging from 1942 to 1968. Tank capacities range from 618,000 gallons to 1,984,000 gallons. In 1995 a HDPE liner covered with flowable fill was installed on the top of the clay floor. The tanks were upgraded with new steel bottoms in 1997 and 1999. TPH GRO and/or DRO was identified in soil samples collected in this area in January 2012 in connection with the proposed demolition of the tanks. (AECOM, 2012). As of the writing of this work plan, all three ASTs have been completely drained of fuel oil. The power plant closure will include removal of these ASTs.	TPH-GRO/DRO
14	Former Railroad Switchyard	Adjacent to southern property boundary and east of Building # 32.	According to the URS Phase I ESA dated December 1999, four transformers likely existed in this area. Soil staining was observed by URS during Site reconnaissance. PCBs were not reported by URS in two oil samples collected by Pepco from each of the transformers that remained. Additionally, a soil sample was collected by Pepco prior to demolition activities in the switchyard and no PCBs were reported. URS could not confirm the location or rationale for the soil sample collected by Pepco. (URS, 1999)	TPH-DRO, PCBs
15	Generating Station Transformers	West of the Generating Station	According to the URS Phase I ESA dated December 1999, approximately 22 transformers with a total capacity of approximately 64,000 gallons were present in the vicinity of the Generating Station Building. Nineteen of these transformers were located on the exterior of the west side of the Generating Station. Pepco's 1993 SPCC-ERP indicated all large power transformers were surrounded by a concrete berm or pit capable of containing all the oil. In addition, the SPCC-ERP indicated some of the smaller service station transformers did not have containment pits or berms. No spills were reported in this area by URS (URS, 1999). All transformers were de-energized and drained to remove oil. Some transformer skeletons remain in place. The two station service transformers were dismantiled and removed from the site in October 2012 following the closure of the power plant.	TPH-DRO, PCBs
16	Print Shop	Southern portion of Building # 32	According to the URS Phase I ESA dated December 1999, the Print Shop stored small quantities (<5 gallons) of various solvents and chemicals. URS could not confirm how long the Print Shop had been in operation. URS reported that Pepco replaced hazardous products with non-hazardous substitutes as they became available. URS did not identify any floor drains in the print shop area. The facility had a silver recovery unit, which extracts silver from used developing chemicals. After the silver was extracted, the remaining non-hazardous fluids were discharged into the sanitary sewer with the approval of the POTW. Print Shop was dismantled and removed. Print Shop operations were relocated or contracted out. An inspection of the print shop area is needed to determine if any other subsurface pathways (expansion joints, compromised concrete, etc) are present. Following this inspection, an evaluation can be made to determine if intrusive activities are necessary.	Metals, VOCs
17	Storm Drain System	Across the site	Based on a review of the USEPA 2009 SI Report, all process water generated on the Site is discharged into the main storm drain that extends across the Site from the southeast corner to the northwest. This pipe discharges through the main outfall (#013) leaving the facility into a pipe that goes under Anacostia Avenue and drains into the Anacostia River. According to the USEPA SI report, there have been no NPDES violations. However, sediment sampling in the discharge location closest to the former Sludge Dewatering Area is needed to evaluate potential for discharge of contaminants to the Anacostia River. A review of the First, Second, and Third Quarter 2012 Discharge Monitoring Reports (DMR) indicates excursions of copper, zinc and iron, and no excursions of PCBs. Pepco is implementing a Total Maximum Daily Load (TMDL) Implementation Plan approved by the USEPA to identify and reduce the sources of metals in the storm water discharges from the facility. Pepco also analyzes for PCB congeners as required by the NPDES permit, for monitoring purposes only.	Metals, PCBs, PAHs
18	Kenilworth Fueling Island	Approximately 105 feet west of Building # 56	The refueling area included one 20,000-gallon gasoline UST. The tank was taken out of service in February 2012 and was removed in August 2012. The soil and groundwater were not impacted and the case was closed with DDOE approval. A leaking UST case was reported in this area resulting from a leaking pressurized pipe associated with the UST in 1996. A remediation system was installed to recover free product and the case was closed by DDOE in September 1997.	TPH-GRO

Table 2
Target Areas
Benning Road Road Facility RI/FS Project
3400 Benning Road, NE
Washington, DC 20019

Notes:
TA - Target Areas
ft bgs - feet below ground surface
UST - underground storage tank
LUST - leaking underground storage tank
mg/kg - milligrams per kilogram
TPH - Total Petroleum Hydrocarbons
GRO - gasoline range organics
DRO - diesel range organics
PCBs - polychlorinated biphenyl s
TSS - total suspended solids
ft - feet
mg/L - milligrams/liter
TA correspond to locations depicted on Figure 5
HDPE - high density polyethylene liner
ASTs - Aboveground Storage Tanks
SPCC-ERP - Spill Prevention Control and Countermeasures - Emergency Response Plan
PPE - Probable Point of Entry
μg/kg - micrograms per kilogram
μg/L - micrograms per Liter
COPC - Contaminant of Potential Concern
NPDES - National Pollutant Discharge Elimination System
PAHs - Polycyclic aromatic hydrocarbons
SI - Site Inspection
USEPA - United States Environmental Protection Agency
DDOE - District Department of the Environment

Table 3
Landside Data Quality Objectives
Benning Road Facility
3400 Benning Road, N.E.
Washington, DC

DQO Step	Site-Specific Information
Step 1: State the Problems	Based on limited sediment sampling, PCBs, PAHs, and metals were detected at elevated levels in the Anacostia River in the vicinity of the Benning Road facility (the Site). Additional environmental assessment including soil and groundwater sampling is necessary at the Site to characterize environmental conditions, refine the CSM and to determine whether past or current conditions at the Site have caused or contributed to contamination of the river. This data is also needed to evaluate the potential for risk to human health and evaluate potential remedial alternatives.
Step 2: Identify the Decisions	1) Has the nature and extent of soil and groundwater contamination been adequately delineated? 2) Are potential target chemical concentrations detected in soil, groundwater or storm drain impacting the river currently or in the past? 3) Is the site-specific hydrogeology and volumetric flux of groundwater to the Anacostia River well understood in the context of the CSM? 4) Is the storm drain system and associated discharge to the Anacostia River at various outfalls well understood in the context of the CSM? 5) Are the target chemical concentrations in soil and groundwater at the Site greater than background concentrations? 6) Are the target chemical concentrations in soil or groundwater present at levels that indicate the potential for risk to human health or the environment?
Step 3: Identify Inputs to the Decision	The key inputs for making the required decisions are briefly summarized as follows: 1) Historical hydrogeological information, geotechnical information, analytical data and Site use/operations documentation. 2) Potential surface soil impacts will be evaluated by collecting 20 surface soil samples for PID and XRF instrument field screening. 3) Potential current or historic discharges from the storm drain system will be evaluated by sampling 5 sediment/residue and 5 water samples. Forensic analysis will be performed on up to 2 samples. 4) Five (5) HSA geotechnical soil borings and ERI will be performed to verify existing data and better characterize Site lithology and potential impacts, respectively. 5) 40 DPT soil borings with XRF field instrument screening and TPH/PCB aroclor analysis using on-site mobile laboratory will be performed to evaluate potential subsurface impacts. Discrete groundwater sampling at DPT locations will be performed to evaluate potential groundwater impacts. 6) HSA-installed monitoring wells, groundwater sampling, and aquifer testing will be performed following site-wide assessment to evaluate potential groundwater impacts and Site-specific hydrogeology. 7) A comprehensive analysis for VOCs, SVOCs, Metals, PCBs, Pesticides, Dioxin, and Furans will be performed selectively in the various media sampled to evaluate for these potential impacts.

Table 3
Landside Data Quality Objectives
Benning Road Facility
3400 Benning Road, N.E.
Washington, DC

DQO Step	Site-Specific Information
Step 4: Define the Study Boundaries	The Landside investigation includes Target Areas identified within the 77-acre Site (i.e. Benning Road Facility located at 3400 Benning Road, Northeast in Washington, DC). The Site is bordered by a DC Solid Waste Transfer Station to the north, Kenilworth Maintenance Yard (owned by the National Park Service, NPS) to the northwest, the Anacostia Avenue and Anacostia River to the west, Benning Road to the south and residential areas to the east and south (across Benning Road).
Step 5: Develop a Decision Rule	1) Historical information will be reviewed to identify potential sources of target chemicals and contamination at the Site. Past or current sources at the Site will then be evaluated using ERI followed by confirmatory soil and groundwater samples at target zones to delineate potential zones of impact and identify any continuing sources of contamination. 2) An evaluation will be performed which compares the analytical results to background to see if the concentrations are consistent with background concentrations. Should concentrations be less than or consistent with background concentrations, then this suggests no unacceptable risk attributable to the Site. 3) If the groundwater and soil concentrations of target chemicals are at or below the conservative human health screening values, then the potential source area will be recommended for no further evaluation. 4) If the soil or groundwater concentrations are above the screening values at a potential source area, the Site data will be further evaluated, including a fate and transport analysis of the target chemicals to characterize the potential impacts to the river.
Step 6: Specify Tolerable Limits of Decision Errors	The data quality indicators for screening and definitive data are defined in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. The assessment of the data quality indicators is necessary to determine data usability and involves the evaluation of the PARCC parameters. To ensure the quality and integrity of the project data, the precision and accuracy of the analysis, the representativeness of the results the completeness of the data, and the comparability of the data to existing data will be evaluated. Data that meet the DQOs and fulfill project goals will be deemed acceptable. Data that do not meet objectives and goals will be reviewed on a case-by-case basis to ascertain its usefulness. To limit errors made based upon analytical data, the reporting limits (practical quantitation limits) for target analytes have been established at a level at least three times less than the action limit whenever technically feasible. In general, statistical analysis will not be used to determine decision error tolerance limits. Generally each sample will be used to make a decision.

Table 3
Landside Data Quality Objectives
Benning Road Facility
3400 Benning Road, N.E.
Washington, DC

DQO Step	Site-Specific Information
Step 7: Optimize the Design	The sampling design incorporates a progressive elimination approach using screening parameters to help focus the sampling and analysis for target chemical concentrations over the Site. The variability of data will have an effect on the sampling design. If necessary, the sample frequency and the analytical procedures may undergo changes to optimize the design. The design options, such as sample collection design, sample size and analytical procedures will be evaluated based on cost and ability to meet the DQOs.

Table 4
Waterside Data Quality Objectives
Benning Road Facility
3400 Benning Road, N.E.
Washington, DC

DQO Step	Site-Specific Information
Step 1: State the Problems	Based on limited sediment sampling, PCBs, PAHs, and metals were detected at elevated levels in the Anacostia River in the vicinity of the Benning Road facility (the Site). Additional sediment and surface water sampling is necessary to identify potential Site-related, near-Site and far-Site sources of COPCs in sediment and surface water and evaluate the potential for risk to human health and the environment.
Step 2: Identify the Decisions	1) Has the nature and extent of sediment contamination been adequately delineated? 2) Are the target chemical concentrations in surface sediments adjacent to the Site greater than upstream from the Site? 3) Are the target chemical concentrations in sub-surface sediments adjacent to the Site greater than upstream from the Site? 4) Are the target chemical concentrations in surface water adjacent to the Site greater than upstream from the Site? 5) Are detected concentrations in surface water or sediment present at levels that indicate the potential for risk to human health or the environment? 6) Is sedimentation in the portion of the Anacostia River in Study Area well understood in the context of the CSM? 7) Are the target chemical concentrations in sediment or surface water present at levels that indicate the potential for risk to human health or the environment?
Step 3: Identify Inputs to the Decision	The key inputs for making the required decisions are briefly summarized as follows: 1) PCBs and PAHs within the Anacostia River will be evaluated by sampling surface water and sediment (surface and sub-surface) from within the Waterside Investigation Area and background locations for laboratory analysis. 2) Inorganics within the Anacostia River will be evaluated by sampling surface water and surface sediment from within the Waterside Investigation Area and background locations for laboratory analysis of inorganics, hardness (water only), grain size (sediment only), TOC (sediment only), and SEM/AVS (sediment only). 3) VOCs, SVOCs, Pesticides, Dioxins, and Furans within the Anacostia River will be evaluated by sampling a sub-set of surface water and sediment (surface) samples from within the Waterside Investigation Area and background locations for laboratory analysis. 4) A sub-set of sediment samples will be collected and submitted for forensic laboratory analysis of PCBs and PAHs to differentiate between Site-related, near-Site and far-Site sources of COPCs.
Step 4: Define the Study Boundaries	The Benning Road facility is located at 3400 Benning Road, Northeast in Washington, DC. The Waterside investigation will primarily address sediment conditions within an area of the Anacostia River approximately 10 to 15 acres in size including approximately 2,500 linear feet to the south (approximately 700 feet south of the Benning Road Bridge) and 1,000 linear feet to the north of the Site's main storm water outfall area.

Table 4
Waterside Data Quality Objectives
Benning Road Facility
3400 Benning Road, N.E.
Washington, DC

DQO Step	Site-Specific Information
Step 5: Develop a Decision Rule	1) A benchmark comparison will be conducted to determine whether the sediment and surface water concentrations of organic and inorganic constituents adjacent to the site are above human health and ecological benchmarks, indicating the potential for risk. a. If the benchmark comparison indicates that adjacent concentrations are below human health and/or ecological benchmarks, then this suggests no unacceptable risk attributable to the site. b. If the benchmark comparison indicates that adjacent concentrations are above human health and/or ecological benchmarks, then additional investigation may be necessary. If the constituent concentrations are less than the sediment quality benchmarks, then those contaminants are not expected to contribute to total site risk. If the contaminant concentrations are greater than the sediment quality benchmarks, then further evaluation may be required. 2) A statistical evaluation will be conducted to determine whether the sediment and surface water concentrations of organic and inorganic constituents adjacent to the site are consistent with upstream conditions. a. If the statistical evaluation indicates that adjacent concentrations are less than or consistent with upstream concentrations, then this suggests no unacceptable risk attributable to the site. b. If the statistical evaluation indicates that adjacent concentrations are greater than upstream concentrations, then additional investigation may be necessary.
Step 6: Specify Tolerable Limits of Decision Errors	The data quality indicators for screening and definitive data are defined in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. The assessment of the data quality indicators is necessary to determine data usability and involves the evaluation of the PARCC parameters. To ensure the quality and integrity of the project data, the precision and accuracy of the analysis, the representativeness of the results the completeness of the data, and the comparability of the data to existing data will be evaluated. Data that meet the DQOs and fulfill project goals will be deemed acceptable. Data that do not meet objectives and goals will be reviewed on a case-by-case basis to ascertain its usefulness. To limit errors made based upon analytical data, the reporting limits (practical quantitation limits) for target analytes have been established at a level at least three times less than the action limit whenever technically feasible. In general, statistical analysis will not be used to determine decision error tolerance limits. Generally each sample will be used to make a decision.

Table 4
Waterside Data Quality Objectives
Benning Road Facility
3400 Benning Road, N.E.
Washington, DC

DQO Step	Site-Specific Information
Step 7: Optimize the Design	The sampling design incorporates a progressive elimination approach utilizing screening parameters to help focus the sampling and analysis and characterize any hotspots in the sediment areas. PCB aroclors analysis, using an on-site mobile laboratory, on all sediment samples will be used for screening purposes. The variability of data will have an effect on the sampling design. If necessary, the sample frequency and the analytical procedures may undergo changes to optimize the design. The design options, such as sample collection design, sample size and analytical procedures will be evaluated based on cost and ability to meet the DQOs.

Table 5: Landside Data Collection Program
Benning Road Facility RI/FS Project
3400 Benning Rd, N.E.

Data Type	Data Use	Approximate Quantity	Methods
Surface Soil Samples (Phase I)			
Chemical analysis	Evaluation of surface soil quality	25 locations	TPH (8015), VOC (8260), PCB (8082), Metals, EPA 16 PAHs (8270)
		Up to 10 locations	VOCs (8260), SVOCs (8270), Pesticides, and Dioxins/furans
Forensic analysis	Evaluation of PCB and PAH origin and contribution	Up to 5 locations	PCB 680 Homologs and/or PCB 1668 Congeners, PAH fingerprinting
Storm Drain System (leading to Outfall 013) Sampling (Phase I)			
Water	Surface water discharge pathway	Up to 9 locations	PCBs (8082), PCB (608), EPA 16 PAHs (8270), dissolved and total Metals, VOCs (8260), TPH (8015), Pesticides
Sediment	Surface water discharge pathway	Up to 9 locations	PCBs (8082), PCB (608), EPA 16 PAHs (8270), Metals, VOCs (8260), TPH (8015), Pesticides
Forensic samples	PCB and PAH origin, site reference, surface water pathway	Up to 2 locations	PCB 680 Homologs, PCB 1668 B Congeners, PAH fingerprinting, dioxins/furans
Surface Geophysics (Phase I)			
Electrical Resistive Imaging (ERI)	Evaluation of subsurface geology, obstructions, NAPL plumes and optimization of soil boring and monitoring well placement	Up to 8 transects of 300-500 ft long	Geo Trax™ Survey
Soil Borings to 100 ft below grade (Phase I)			
Lithology	Subsurface geology	Continuous	Visual identification
PID Reading	Screening for VOCs	Continuous	Field methods
Geotechnical	Subsurface geology	25 samples (5 locations, and up to 5 samples per location)	ASTM Grain size and Atterberg limits
Geotechnical	Subsurface geology	10 Shelby tubes (5 locations and two samples per boring)	ASTM Permeability
Subsurface Soil and Groundwater Samples (Phase II)			
Direct Push (Geoprobe™) Borings to 5 ft below groundwater	Subsurface geology, identification of free phase oils	40 locations	Visual identification
VOC Vapor Screen	Rapid characterization, flexibility to field adjust sampling grid	Continuous	Photoionization Detector (PID) field instrument
Metals screen	Subsurface soil quality, rapid characterization, flexibility to field adjust sampling grid	120 samples (three depths at 40 locations)	X-Ray Fluorescence (XRF) field instrument
Soil chemical	Rapid characterization, flexibility to field adjust sampling grid	120 samples (three depths at 40 locations)	Mobile lab TPH (8015) and PCBs (8082)
Soil chemical	Metals confirmation/correlation	24 samples (20% of 120)	Metals (fixed lab)
Soil chemcial	Evaluation of subsurface soil quality	Up to 40 samples	VOCs (8260), PAHs (8270)
Soil chemical	Evaluation of subsurface soil quality	Up to 10 samples	Pesticides, SVOC (8270), dioxins/furans
Groundwater chemical	Evaluation of groundwater quality	40 locations	Mobile lab TPH (8015) and PCBs (8082)
Groundwater chemical	Evaluation of groundwater quality	40 locations	VOCs (8260), EPA 16 PAHs (8270), total and dissolved metals

Table 5: Landside Data Collection Program
Benning Road Facility RI/FS Project
3400 Benning Rd, N.E.

Groundwater chemical	Evaluation of groundwater quality	Up to 10 samples	Pesticides, SVOC (8270), dioxins/furans
Forensic analysis	Evaluation of PCB and PAH origin and contribution	Up to 5 soil/groundwater samples	PCB 680 Homologs, PCB 1668 Congeners, PAH fingerprinting
Monitoring Wells to the top of Arundel Clay (Phase III) *			
GW elevation monitoring	Determine depth to groundwater and groundwater gradient	TBD	Gauging
Aquifer testing	Evaluation of aquifer characteristics	TBD	Slug Testing
Chemical analysis	Evaluation of groundwater quality	TBD	VOC (8260), PCB (8082), dissolved and total Metals, EPA 16 PAHs (8270), SVOC (8270), pesticides
Chemical analysis	Evaluation of groundwater quality	TBD	Pesticides, dioxins/furans
Forensic analysis	Evaluation of PCB and PAH origin and contribution	TBD	PCB 680 Homologs and/or PCB 1668 Congeners, PAH fingerprinting
Civil Surveying			
Horizontal and vertical surveys	To locate all sampling points	All locations sampled in Phases I, II and III	GPS surveys

* Number and location of monitoring wells to be determined following evaluation of results from Phase I and Phase II.

Table 6: Waterside Data Collection Program
Benning Road Facility RI/FS Project
3400 Benning Rd, N.E.

Data Type	Data Use	Approximate Quantity	Methods
River Bottom Surveys (Phase I)			
Bathymetric survey	Understanding of depth of the water column and configuration of river bottom	Investigation area and background locations	USACE Hydrographic survey methods (Differential Geographic Positioning System, DGPS)
Utility Survey	Confirm utilities and other underwater obstructions	Investigation area and background locations	Side scan sonar
Surface Water Samples (Phase II)			
General chemistry	Evaluation of surface water quality near sediment-water interface	20 locations (10 transects + up to 10 background)	Field methods for measuring temperature, pH, turbidity, dissolved oxygen and conductivity
Chemical analysis	Surface water impacts	20 locations (10 transects + up to 10 background)	PCBs (8082), EPA 16 PAHs (8270), and Total and dissolved phase Metals (including hardness)
		Up to 10 locations	Oil and Grease (1664A), VOCs (8260), SVOCs (8270), Pesticides, and Dioxins/furans
Surface Sediment Samples (Phase II)			
Chemical analysis	Evaluation of surface sediment quality and background surface sediment quality	55 samples (45 near the site + up to 10 background)	PCBs (8082), Metals, EPA 16 PAHs (8270), AVS/SEM
		Up to 20 samples	VOCs (8260), SVOC (8270), Pesticides, and Dioxins/furans
Sediment characteristics	Evaluation of surface sediment quality and background surface sediment quality	55 samples (45 near the site + up to 10 background)	Total Organic Carbon (TOC), ASTM grain size
Forensic analysis	Evaluation of PCB and PAH origin and contribution	Up to 8 samples	PCB 680 Homologs and/or PCB 1668 Congeners, PAH fingerprinting
Subsurface Sediment Samples (phase II)			
Vibracore Borings (8 to 10 ft deep depending on refusal)	Sediment physical characteristics	55 samples (45 near the site + up to 10 background)	Visual identification
Chemical analysis	Evaluation of subsurface sediment quality and background surface sediment quality	165 samples (3 depths at 55 locations)	PCB (8082) and PAH16 (8270)
Forensic analysis	Evaluation of PCB and PAH origin and contribution	Up to 7 samples	PCB 680 Homologs and/or PCB 1668 Congeners, PAH fingerprinting
Geotech	Evaluation of subsurface sediment physical characteristics	Up to 20 samples	ASTM Grain size and TOC

Table 7
Project Team
Benning Road Facility RI/FS Project
3400 Benning Road, NE
Washington, DC 20019

Title	Name	Telephone Number	Email
Pepco Project Manager	Fariba Mahvi	(202) 331-6641 (office); (202) 345-7647 (mobile)	fmahvi@pepco.com
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	Sean Crouch (Alternate)	(240) 565-6517 (office); (443) 878-0551 (mobile)	sean.crouch@aecom.com
Data Manager	To be determined	To be determined	To be determined
Subcontractors	To be determined	To be determined	To be determined

Pepco
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Appendix A

Site Drainage Map

PCB and Iron Source Tracking Pollutant Minimization Plan

Drainage Area Map

Benning Generating Station
Potomac Electric Power Company, Inc.
Washington, DC

Prepared by - Date: THP - 11/21/11

Checked by - Date: LRP - 11/21/11

Project Number: 6123100052

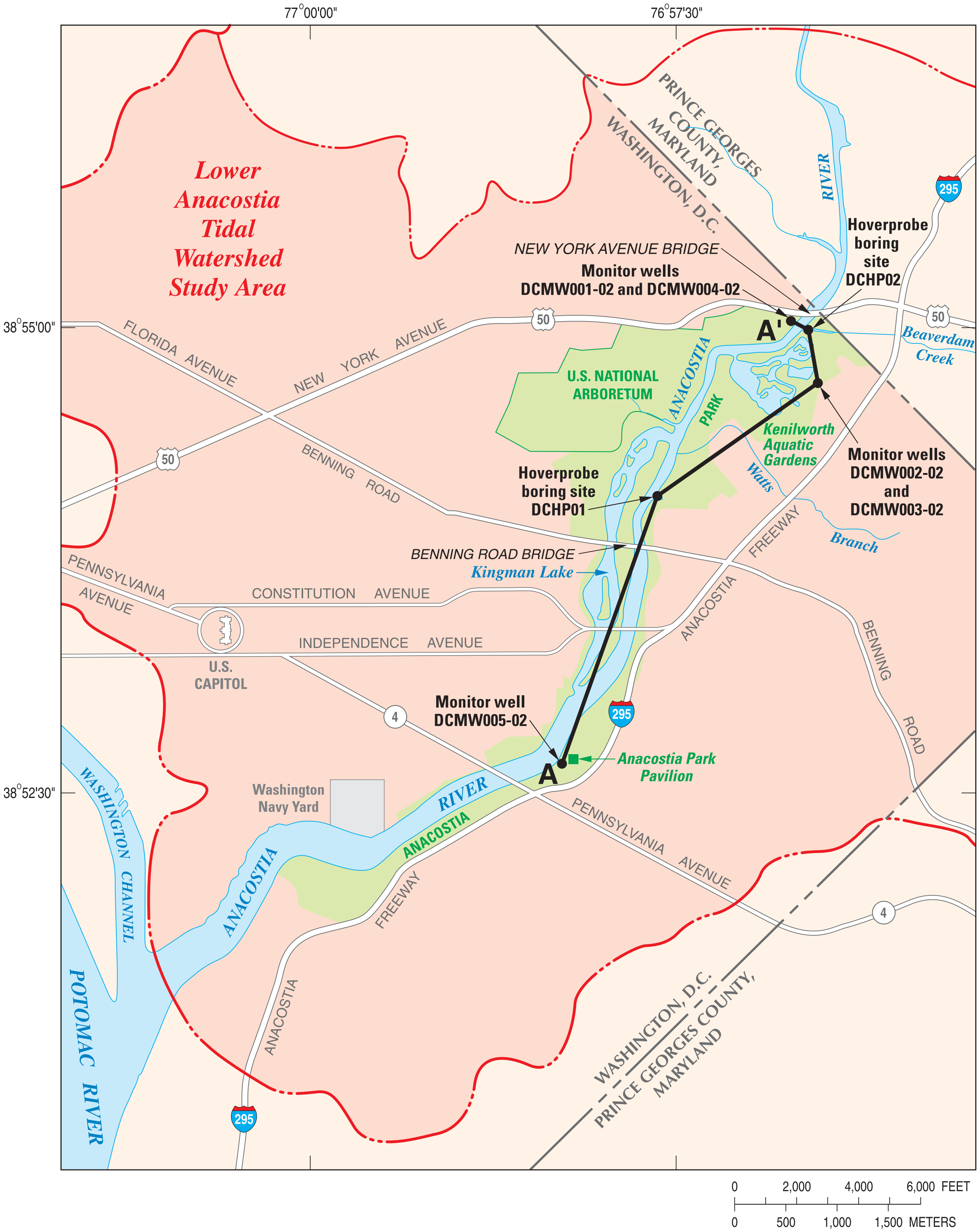
amec

Figure Number: 1

Appendix B

USGS Lithologic Section along the Anacostia River

USGS. 2002. Lithologic Coring in the Lower Anacostia Tidal Watershed, Washington, D.C. Report 03-318.

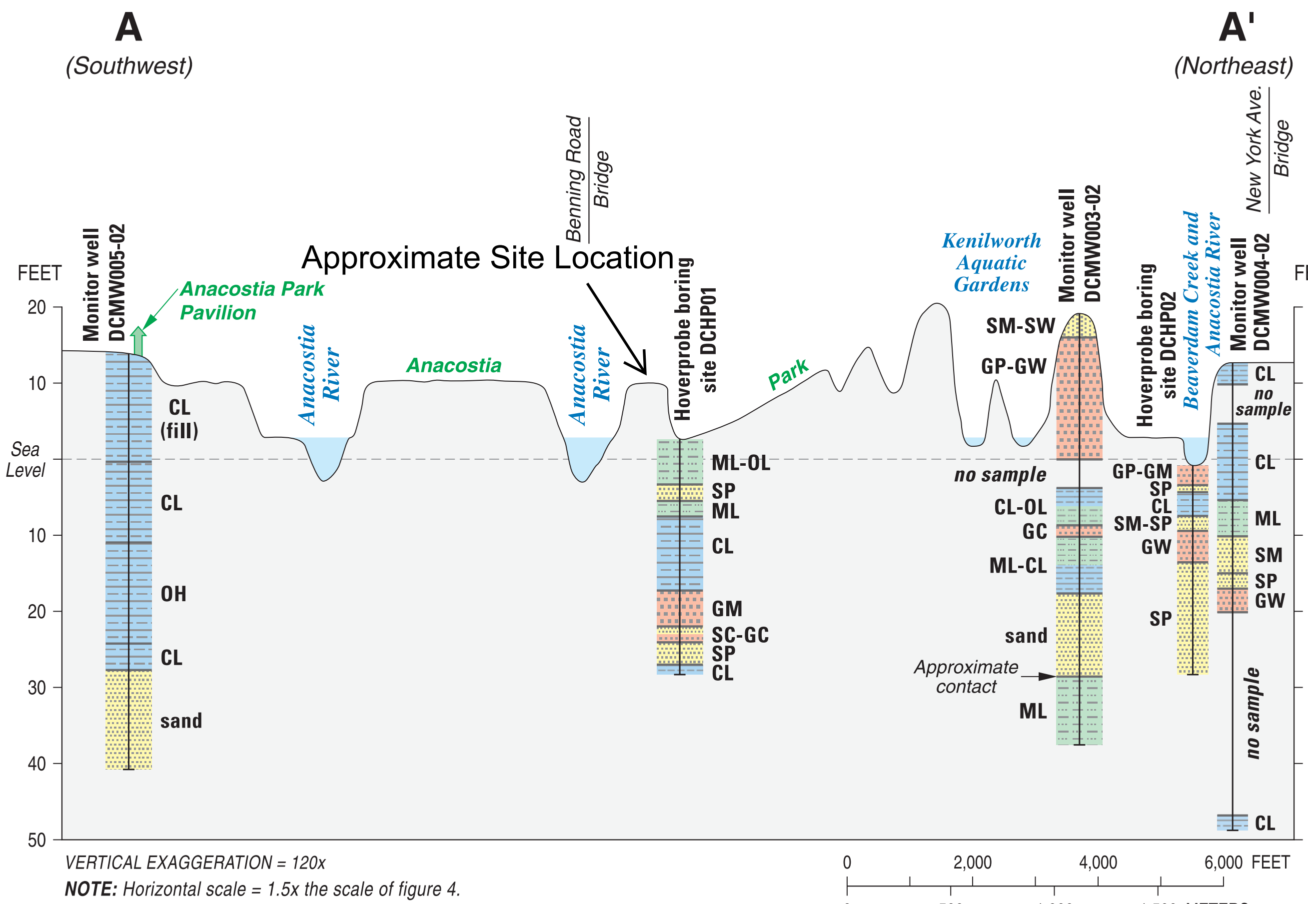


EXPLANATION

DCHP01 ● LOCATION OF MONITOR WELLS AND HOVERPROBE BORING SITES AND IDENTIFICATION NUMBER

A——A' TRACE OF LITHOLOGIC SECTION

Figure 4. Location of monitor wells, hoverprobe boring sites, and trace of lithologic section A-A' along the Anacostia River, Washington, D.C., July 2002.



EXPLANATION

DCHP01

MONITOR WELL OR HOVERPROBE BORING SITE AND IDENTIFICATION NUMBER

STRATIGRAPHIC CONTACT

UNIFIED SOIL CLASSIFICATION SYSTEM

SYMBOL AND MAJOR DIVISION	*LETTER*	*DESCRIPTION*
GRAVEL	GP	Poorly graded gravel
	GW	Well graded gravel
	GM	Silty gravel
	GC	Clayey gravel
SAND	SP	Poorly graded sand
	SW	Well graded sand
	SM	Silty sand
	SC	Clayey sand
SILT	ML	Inorganic silt, very fine sand, and clayey silt
	OL	Organic silt and organic clayey silt
CLAY	CL	Inorganic clay, silty clay, and sandy clay
	OH	Organic clay

Figure 7. Lithologic section A-A' along the Anacostia River, Washington, D.C.

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Appendix C

Anacostia River Watershed Maps

USGS. 2002. Lithologic Coring in the Lower Anacostia Tidal Watershed, Washington, D.C. Report 03-318.

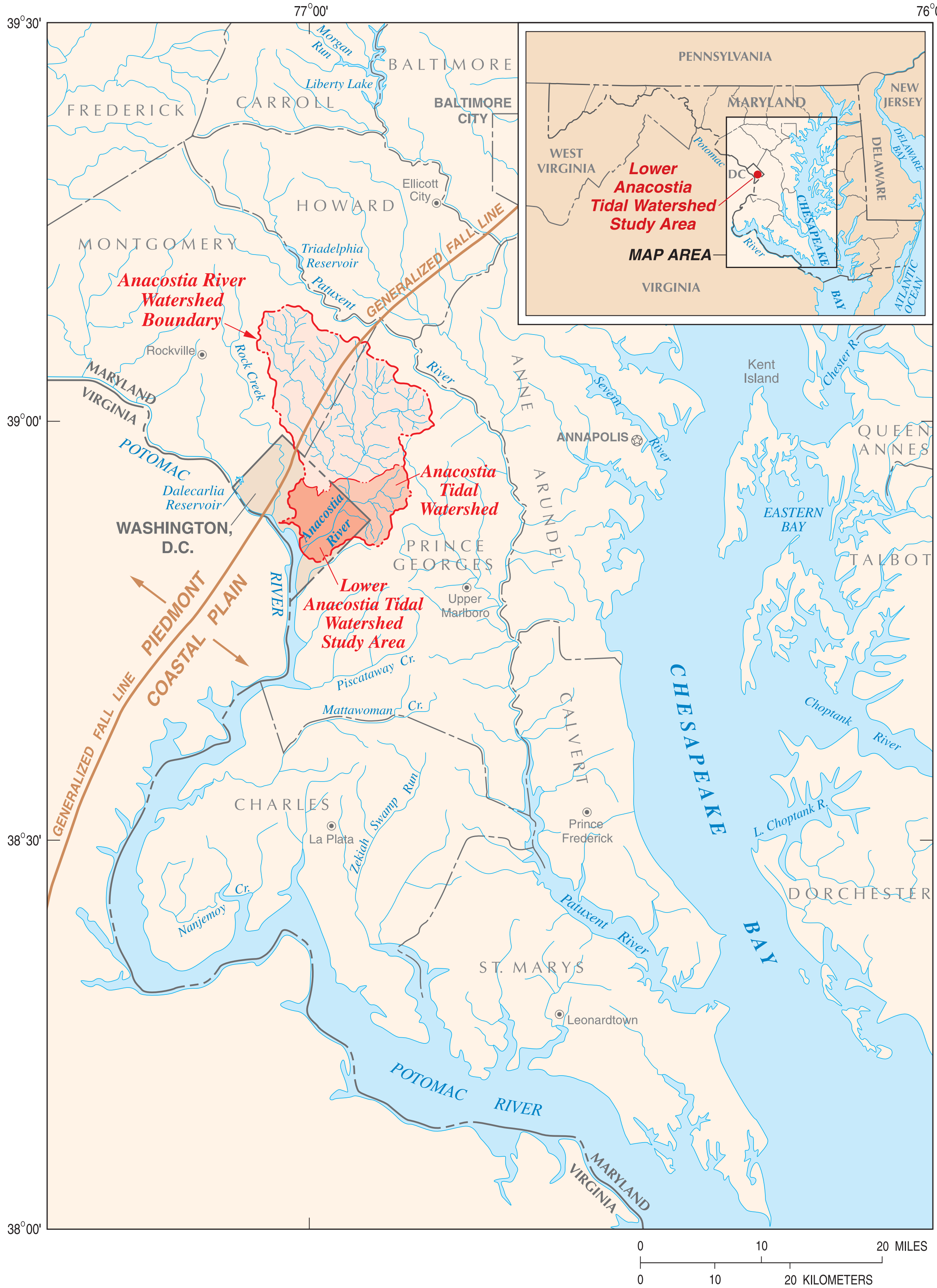
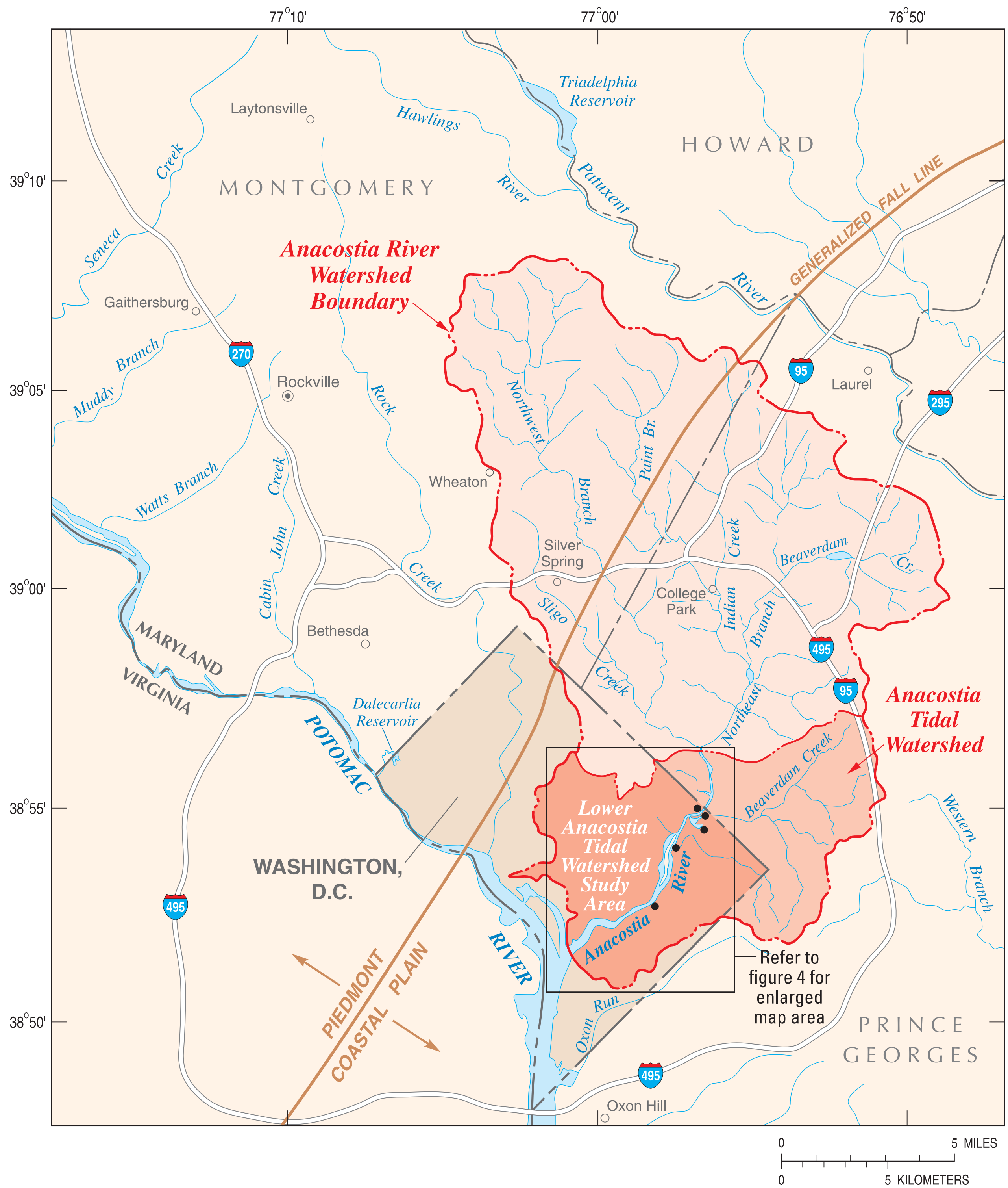


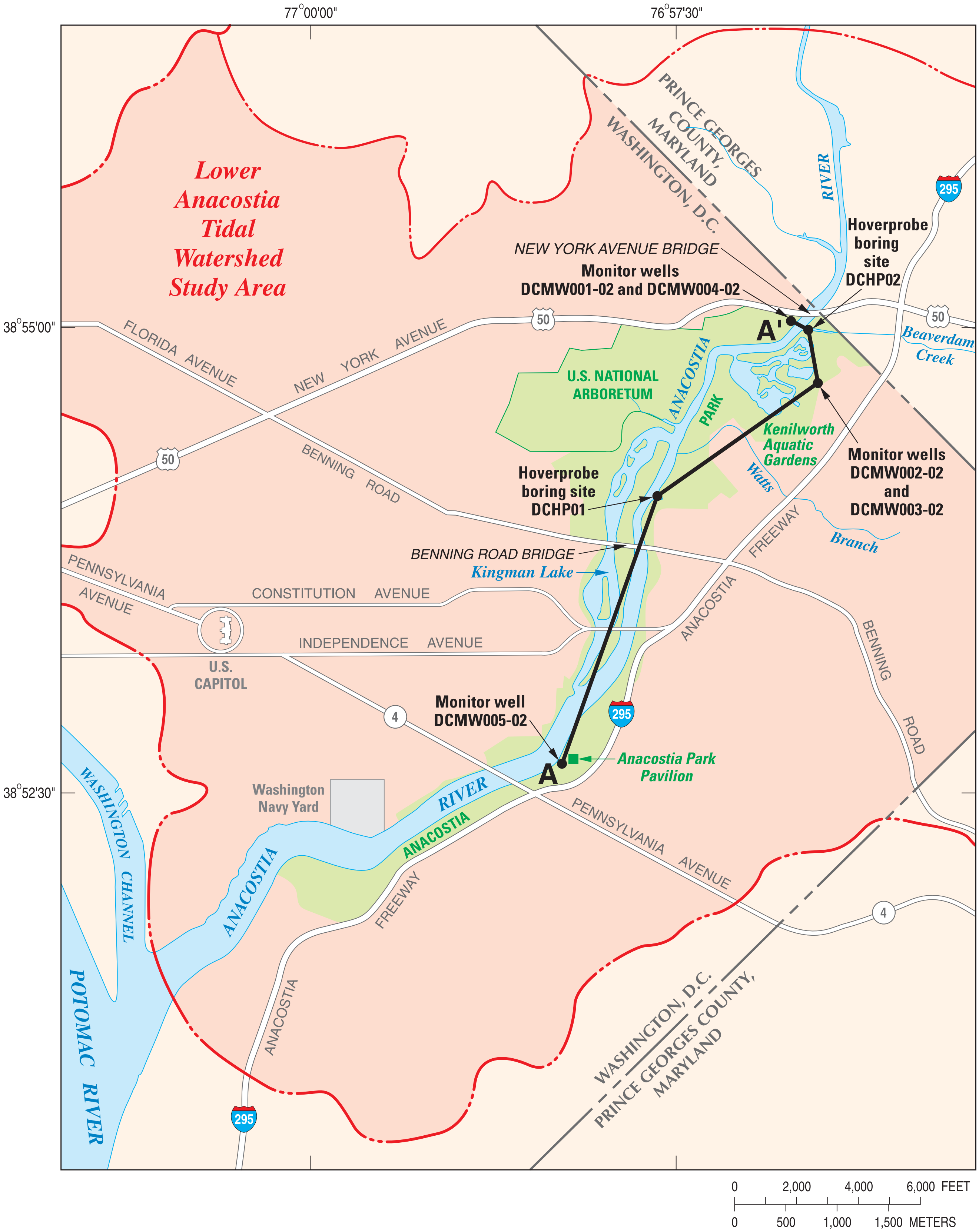
Figure 1a. Location of the Anacostia River watershed and the lower Anacostia tidal watershed study area in Washington, D.C.



EXPLANATION

● LOCATION OF MONITOR WELLS AND HOVERPROBE BORING SITES (Refer to figure 4 for site locations and identification numbers.)

Figure 1b. Detailed view of the Anacostia River watershed, the lower Anacostia tidal watershed study area in Washington, D.C., and location of monitor wells and hoverprobe boring sites.



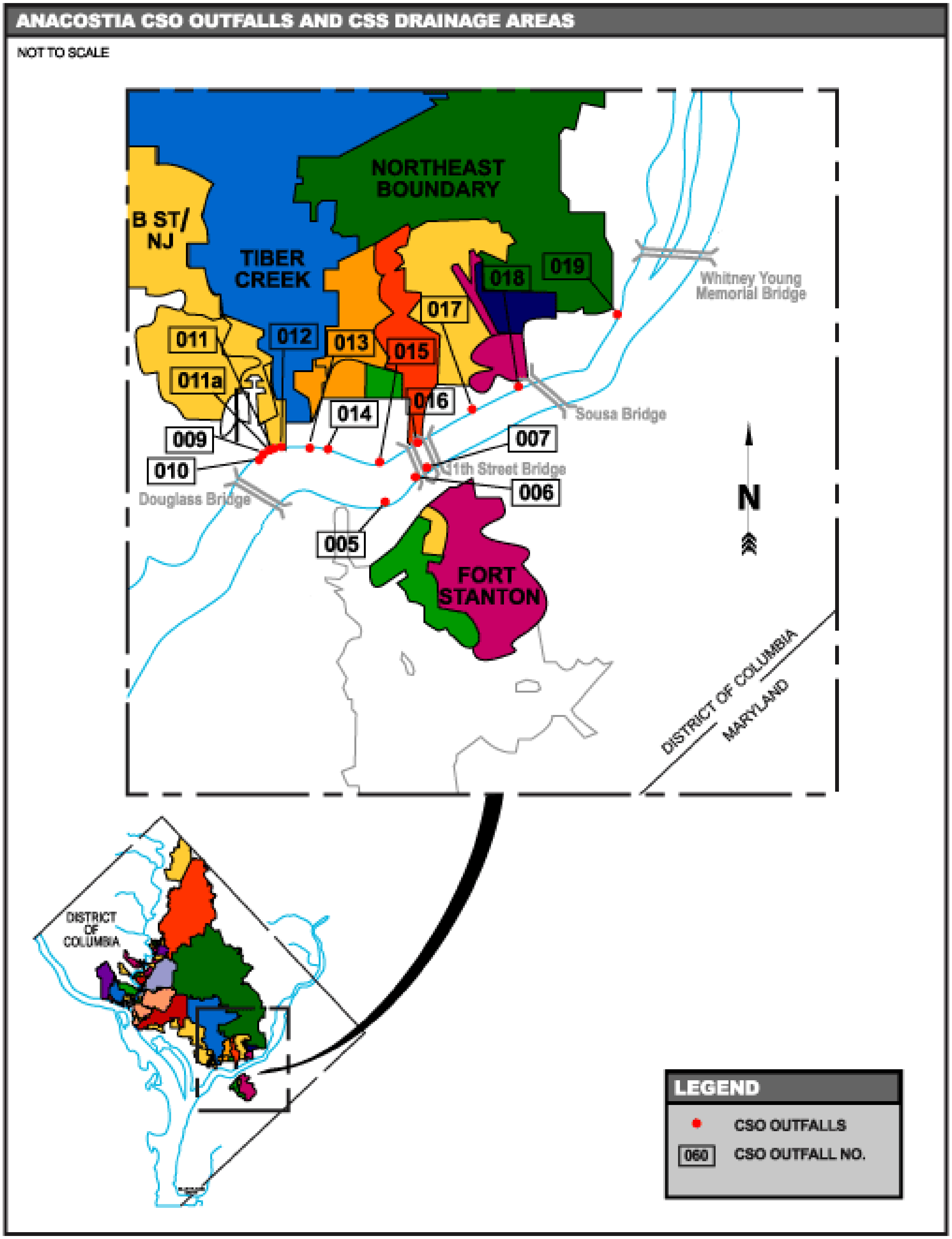
EXPLANATION

DCHP01 ● LOCATION OF MONITOR WELLS AND HOVERPROBE BORING SITES AND IDENTIFICATION NUMBER

A——A' TRACE OF LITHOLOGIC SECTION

Figure 4. Location of monitor wells, hoverprobe boring sites, and trace of lithologic section A-A' along the Anacostia River, Washington, D.C., July 2002.

Appendix B: CSO Outfalls and Drainage Areas



Source: http://www.dcwasa.com/wastewater_collection/css/default.cfm

Appendix D

Existing Anacostia River Chemical Data based on NOAA Database

N
W E
S

Total PCBs Concentrations in the Anacostia River Surficial Sediment
Benning Road Facility RI/FS Project
3400 Benning Rd., NE
Washington, DC 20019

0 0.475 0.95 1.9 Miles

Data presented has been queried from the NOAA Query Manager Database and may include data from the following studies:
1980-92 VA State Water Control Board
1981-82 MD OEP Water Monitoring Data
1986-99 NSWC White Oak Env. GIS Layer
1989 ICPRB/Limno-Tech Sediment Survey
1990 EMAP - Chesapeake Bay
1991 EMAP - Chesapeake Bay
1992 Bolling AFB - SW Corner
1992 Potomac & Anacostia Sediment Study
1993 EMAP - Chesapeake Bay
1993 FWS Kennilworth Marsh
1995 PEPCO
1995 Washington Navy Yard
1996 PWS PAH/PCB - Mason Neck
1996 WA Gas - East Station Project
1996 Wetland Restoration - Kennilworth
1997 DC Sediment Core Analysis
1998 BARC RI
1998 USACE Federal Nav Channel
1999 AWTA Sediment Quality Triad
1999 GSA SE Federal Center
1999 WA Navy Yard RI
2000 ANS Sediment Study
2000 Ambient Tox Chesapeake Bay
2000 USFWS Bioavailability
2003 Active Capping Site Char Rpt
2009 Final Site Inspection Report

Total PCBs (ppm)
<59.8
59.8 - 676
676 - 5000
5000 - 100000+
Non-Detect
No Record

From 2009 SI Report
<59.8
59.8 - 676
676 - 5000
5000 - 10000

Note: Totals from 2009 SI Report are sums of Aroclors 1254 and 1260

Proposed Sampling Location
Property Boundaries
Proposed Study Area
Riverine Boundary

AECOM

Figure 1

Total PAH Concentrations in the Anacostia River Surficial Sediment
Benning Road Facility RI/FS Project
3400 Benning Rd., NE
Washington, DC 20019

0 0.475 0.95 1.9 Miles

Data presented has been queried from the NOAA Query Manager Database and may include data from the following studies:
1980-92 VA State Water Control Board
1981-82 MD OEP Water Monitoring Data
1986-99 NSWC White Oak Env. GIS Layer
1989 ICPRB/Limno-Tech Sediment Survey
1990 EMAP - Chesapeake Bay
1991 EMAP - Chesapeake Bay
1992 Bolling AFB - SW Corner
1992 Potomac & Anacostia Sediment Study
1993 EMAP - Chesapeake Bay
1993 FWS Kennilworth Marsh
1995 PEPCO
1995 Washington Navy Yard
1996 PWS PAH/PCB - Mason Neck
1996 WA Gas - East Station Project
1996 Wetland Restoration - Kennilworth
1997 DC Sediment Core Analysis
1998 BARC RI
1998 USACE Federal Nav Channel
1999 AWTA Sediment Quality Triad
1999 GSA SE Federal Center
1999 WA Navy Yard RI
2000 ANS Sediment Study
2000 Ambient Tox Chesapeake Bay
2000 USFWS Bioavailability
2003 Active Capping Site Char Rpt
2009 Final Site Investigation Report

PAH values (ppm)

<1.61
1.61 - 22.8
22.8 - 50.0
50.0 - 100.0
100 +
Non-Detect
No Record
Proposed Sampling Location
Proposed Study Area
Property Boundaries
Riverine Boundary

AECOM

Figure 2

N
W E
S

Total Cadmium Concentrations in the Anacostia River Surficial Sediment
Benning Road Facility RI/FS Project
3400 Benning Rd., NE
Washington, DC 20019

0 0.475 0.95 1.9 Miles

Data presented has been queried from the NOAA Query Manager Database and may include data from the following studies:
1980-92 VA State Water Control Board
1981-82 MD OEP Water Monitoring Data
1986-99 NSWC White Oak Env. GIS Layer
1989 ICPRB/Limno-Tech Sediment Survey
1990 EMAP - Chesapeake Bay
1991 EMAP - Chesapeake Bay
1992 Bolling AFB - SW Corner
1992 Potomac & Anacostia Sediment Study
1993 EMAP - Chesapeake Bay
1993 FWS Kennilworth Marsh
1995 PEPCO
1995 Washington Navy Yard
1996 PWS PAH/PCB - Mason Neck
1996 WA Gas - East Station Project
1996 Wetland Restoration - Kennilworth
1997 DC Sediment Core Analysis
1998 BARC RI
1998 USACE Federal Nav Channel
1999 AWTA Sediment Quality Triad
1999 GSA SE Federal Center
1999 WA Navy Yard RI
2000 ANS Sediment Study
2000 Ambient Tox Chesapeake Bay
2000 USFWS Bioavailability
2003 Active Capping Site Char Rpt
2009 Final Site Inspection Report

Total Cadmium (mg/kg)
- <0.99
- 0.99 - 4.98
- 4.98+
- Non-Detect
- No Record
- Proposed Sampling Location
- Proposed Study Area
- Property Boundaries
- Riverine Boundary

AECOM

Figure 3

Total Copper Concentrations in the Anacostia River Surficial Sediment
Benning Road Facility RI/FS Project
3400 Benning Rd., NE
Washington, DC 20019

0 0.475 0.95 1.9 Miles

Data presented has been queried from the NOAA Query Manager Database and may include data from the following studies:
1980-92 VA State Water Control Board
1981-82 MD OEP Water Monitoring Data
1986-99 NSWC White Oak Env. GIS Layer
1989 ICPRB/Limno-Tech Sediment Survey
1990 EMAP - Chesapeake Bay
1991 EMAP - Chesapeake Bay
1992 Bolling AFB - SW Corner
1992 Potomac & Anacostia Sediment Study
1993 EMAP - Chesapeake Bay
1993 FWS Kennilworth Marsh
1995 PEPCO
1995 Washington Navy Yard
1996 PWS PAH/PCB - Mason Neck
1996 WA Gas - East Station Project
1996 Wetland Restoration - Kennilworth
1997 DC Sediment Core Analysis
1998 BARC RI
1998 USACE Federal Nav Channel
1999 AWTA Sediment Quality Triad
1999 GSA SE Federal Center
1999 WA Navy Yard RI
2000 ANS Sediment Study
2000 Ambient Tox Chesapeake Bay
2000 USFWS Bioavailability
2003 Active Capping Site Char Rpt
2009 Final Site Inspection Report

Total Copper (mg/kg)

- <31.6
- 31.6 - 149.0
- 149.0+
- Non-Detect
- No Record
- Proposed Sampling Location
- Proposed Study Area
- Property Boundaries
- Riverine Boundary

AECOM

Figure 4

Total Lead Concentrations in the Anacostia River Surficial Sediment
Benning Road Facility RI/FS Project
3400 Benning Rd., NE
Washington, DC 20019

0 0.475 0.95 1.9 Miles

Data presented has been queried from the NOAA Query Manager Database and may include data from the following studies:
1980-92 VA State Water Control Board
1981-82 MD OEP Water Monitoring Data
1986-99 NSWC White Oak Env. GIS Layer
1989 ICPRB/Limno-Tech Sediment Survey
1990 EMAP - Chesapeake Bay
1991 EMAP - Chesapeake Bay
1992 Bolling AFB - SW Corner
1992 Potomac & Anacostia Sediment Study
1993 EMAP - Chesapeake Bay
1993 FWS Kennilworth Marsh
1995 PEPCO
1995 Washington Navy Yard
1996 PWS PAH/PCB - Mason Neck
1996 WA Gas - East Station Project
1996 Wetland Restoration - Kennilworth
1997 DC Sediment Core Analysis
1998 BARC RI
1998 USACE Federal Nav Channel
1999 AWTA Sediment Quality Triad
1999 GSA SE Federal Center
1999 WA Navy Yard RI
2000 ANS Sediment Study
2000 Ambient Tox Chesapeake Bay
2000 USFWS Bioavailability
2003 Active Capping Site Char Rpt
2009 Final Site Inspection Report

Total Lead (mg/kg)
- <35.8
- 35.8 - 128.0
- 128.0+
- Non-Detect
- No Record
- Proposed Sampling Location
- Proposed Study Area
- Property Boundaries
- Riverine Boundary

AECOM

Figure 5

Total Nickle Concentrations in the Anacostia River Surficial Sediment
Benning Road Facility RI/FS Project
3400 Benning Rd., NE
Washington, DC 20019

Data presented has been queried from the NOAA Query Manager Database and may include data from the following studies:
1980-92 VA State Water Control Board
1981-82 MD OEP Water Monitoring Data
1986-99 NSWC White Oak Env. GIS Layer
1989 ICPRB/Limno-Tech Sediment Survey
1990 EMAP - Chesapeake Bay
1991 EMAP - Chesapeake Bay
1992 Bolling AFB - SW Corner
1992 Potomac & Anacostia Sediment Study
1993 EMAP - Chesapeake Bay
1993 FWS Kennilworth Marsh
1995 PEPCO
1995 Washington Navy Yard
1996 PWS PAH/PCB - Mason Neck
1996 WA Gas - East Station Project
1996 Wetland Restoration - Kennilworth
1997 DC Sediment Core Analysis
1998 BARC RI
1998 USACE Federal Nav Channel
1999 AWTA Sediment Quality Triad
1999 GSA SE Federal Center
1999 WA Navy Yard RI
2000 ANS Sediment Study
2000 Ambient Tox Chesapeake Bay
2000 USFWS Bioavailability
2003 Active Capping Site Char Rpt
2009 Final Site Inspection Report

Total Nickle (mg/kg)

<22.7
22.7 - 48.6
48.6+
Non-Detect
No Record
Proposed Sampling Location
Proposed Study Area
Property Boundaries
Riverine Boundary

AECOM

Figure 6

N
W E
S

Total Zinc Concentrations in the Anacostia River Surficial Sediment
Benning Road Facility RI/FS Project
3400 Benning Rd., NE
Washington, DC 20019

0 0.475 0.95 1.9 Miles

Data presented has been queried from the NOAA Query Manager Database and may include data from the following studies:
1980-92 VA State Water Control Board
1981-82 MD OEP Water Monitoring Data
1986-99 NSWC White Oak Env. GIS Layer
1989 ICPRB/Limno-Tech Sediment Survey
1990 EMAP - Chesapeake Bay
1991 EMAP - Chesapeake Bay
1992 Bolling AFB - SW Corner
1992 Potomac & Anacostia Sediment Study
1993 EMAP - Chesapeake Bay
1993 FWS Kennilworth Marsh
1995 PEPCO
1995 Washington Navy Yard
1996 PWS PAH/PCB - Mason Neck
1996 WA Gas - East Station Project
1996 Wetland Restoration - Kennilworth
1997 DC Sediment Core Analysis
1998 BARC RI
1998 USACE Federal Nav Channel
1999 AWTA Sediment Quality Triad
1999 GSA SE Federal Center
1999 WA Navy Yard RI
2000 ANS Sediment Study
2000 Ambient Tox Chesapeake Bay
2000 USFWS Bioavailability
2003 Active Capping Site Char Rpt
2009 Final Site Inspection Report

Total Zinc (mg/kg)
<121.0
121.0 - 459.0
459.0+
Non-Detect
No Record
Proposed Sampling Location
Proposed Study Area
Property Boundaries
WetlandPly

AECOM

Figure 7

pepco

A PHI Company

Appendix E

Human Health Risk Assessment Work Plan

Contents

1 Introduction

This baseline human health risk assessment (HHRA) work plan has been prepared to present methodology that will be used to evaluate potential human health risks at the Benning Road facility (the Site) and a segment of the Anacostia River adjacent to the Site. Together, the Site and the adjacent segment of the River are referred to herein as the “Study Area”. The results of the baseline HHRA will be used to help inform the need for any additional evaluation and/or remedial action within the Study Area.

The 77-acre Site is bordered by a DC Solid Waste Transfer Station to the north, Kenilworth Maintenance Yard (owned by the National Park Service, NPS) to the northwest, the Anacostia River to the west, Benning Road to the south and residential areas to the east and south (across Benning Rd.). The general Site location is shown in **Figure 1** of the RI/FS Work Plan. Most of the Site is comprised of the Benning Service Center, which involves activities related to construction, operation and maintenance of Pepco’s electric power transmission and distribution system serving the Washington, D.C., area. The Service Center accommodates more than 700 Pepco employees responsible for maintenance and construction of Pepco’s electric transmission and distribution system; system engineering; vehicle fleet maintenance and refueling; and central warehousing for materials, supplies and equipment. The Site houses three active electrical substations that support Pepco’s distribution network. The Site is also the location of the Benning Road Power Plant, which is scheduled to be shut down in 2012. The majority of the Site is covered by impervious material such as asphalt or concrete. Active construction/staging areas that are not covered in impervious material are covered in gravel. Public access to the Site is restricted by perimeter fences and two guarded entrances that are manned 24 hours a day and seven days a week.

Based on the limited access and tight security, and the presence of pavement and/or soil cover across the vast majority of the facility where current or historical operations took place, there is very little potential for individuals to trespass onto the Site and come into contact with impacted surface soils. The presence of pavement and soil cover also limits the potential for on-site workers to come into contact with surface soils. The facility’s operating procedures and administrative controls prevent or manage potential exposure to impacted subsurface soils by workers who may perform excavation activities on-site. Groundwater is not used as a source of drinking water; drinking water in the area is provided by a remote municipal source (DC Water). In short, potential direct contact exposure pathways for on-site impacted soils and/or groundwater now or in the foreseeable future are concluded to be incomplete or effectively controlled through administrative measures.

Any on-site impacts are not expected to pose a threat to human health via air migration to off-site receptors. General site conditions, including the presence of impervious or gravel surfaces across most of the site, are expected to prevent or limit the generation of soil-derived fugitive dust emissions. Exposure via inhalation of soil-derived fugitive dust by off-site receptors is typically negligible, particularly if the surface soil is covered and downwind receptors are not located at the fence line (USEPA, 2002e; 1991c). The USEPA's Site Inspection report also concludes that the soil-to-offsite air migration pathway is insignificant: "contamination detected on the site does not pose a significant threat to the air migration pathway" (USEPA, 2009). Based on these considerations, the off-site air migration pathway is not significant enough to evaluate further in the HHRA.

USEPA has noted that contaminant migration via stormwater flows (both overland and through storm drains) and groundwater discharges to the Anacostia River may be of concern; the RI will collect data to determine/confirm these potential migration pathways.

The completed or potentially completed exposure pathways are reflected in the preliminary Conceptual Site Model (CSM) described in Section 3 of the RI/FS Work Plan, and illustrated on **Figure 9** of the Work Plan. The HHRA will evaluate all of the completed or potentially completed exposure pathways after any refinements to the CSM based on the findings of the RI work.

The baseline HHRA will be conducted in accordance with applicable USEPA guidance including, but not limited to, the following:

- Risk Assessment Guidance for Superfund (RAGS): Volume 1 - Human Health Evaluation Manual (Part A) (USEPA, 1989a);
- Human Health Evaluation Manual Supplemental Guidance; Standard Default Exposure Factors (USEPA, 1991a);
- Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. OSWER 9655.0-30. April, 1991. (USEPA, 1991b);
- Guidance for Data Usability in Risk Assessment (Part A) (USEPA, 1992a);
- Guidelines for Exposure Assessment (USEPA, 1992b);
- Guidance Manual for the Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children. Publication 9285.7-15-1. February 1994 (USEPA, 1994), and associated, clarifying, Short Sheets on IEUBK Model inputs, including, but not limited to, OSWER 9285.7-32 through 34, as listed on the OSWER lead internet site at www.epa.gov/superfund/programs/lead/prods.htm;
- Land Use in the CERCLA Remedy Selection Process (USEPA, 1995);

- Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposure to Lead in Soil (USEPA, 1996);
- Exposure Factors Handbook (EFH) (USEPA, 2011);
- Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (USEPA 2002a);
- Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children. Windows version©. (USEPA, 2002b);
- Human Health Toxicity Values in Superfund Risk Assessments, OSWER Directive 9285.7-53 (USEPA 2003);
- RAGs: Volume I. Human Health Evaluation Manual. Part E, Supplemental Guidance for Dermal Risk Assessment (USEPA, 2004);
- Guidelines for Carcinogen Risk Assessment (USEPA, 2005a);
- Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens (USEPA, 2005b):
- Child-Specific Exposure Factors Handbook (USEPA 2008);
- ProUCL Version 4.1.01 (or the most currently available version, available from http://www.epa.gov/osp/hstl/tsc/software.htm, Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations; and
- USEPA Regional Screening Levels (USEPA, 2012a,b).

The HHRA will evaluate potential human health effects using the four step paradigm as identified by the USEPA in the *Risk Assessment Guidance for Superfund, Volume I – Human Health Evaluation Manual* (USEPA, 1989a). The steps are:

- Data Evaluation and Hazard Identification;
- Dose-Response Assessment;
- Exposure Assessment; and
- Risk Characterization.

The HHRA work plan is organized into the following sections:

- Data Evaluation and Hazard Identification – Section 2 presents the methods to be used in the data evaluation and hazard identification, including selection of chemicals of potential concern (COPCs) that will be evaluated quantitatively in the risk assessment;

- Dose-Response Assessment – Section 3 presents a discussion of the dose-response assessment process. The dose-response assessment evaluates the relationship between the magnitude of exposure (dose) and the potential for occurrence of specific health effects (response) for each COPC. Both potential carcinogenic and non-carcinogenic effects will be considered. The most current USEPA-verified dose-response values will be used when available;
- Exposure Assessment - Section 4 presents a discussion of the exposure assessment process. The purpose of the exposure assessment is to provide a quantitative estimate of the magnitude and frequency of potential exposure to COPCs by a receptor. Potentially exposed individuals, and the pathways through which those individuals may be exposed to COPCs are identified based on the physical characteristics of the Study Area, as well as the current and reasonably foreseeable future uses of the Site and surrounding area. The extent of a receptor's exposure is estimated by constructing exposure scenarios that describe the potential pathways of exposure to COPCs and the activities and behaviors of individuals that might lead to contact with COPCs in the environment;
- Risk Characterization – Section 5 presents a discussion of the risk characterization process and uncertainties associated with the risk assessment process. Risk characterization combines the results of the exposure assessment and the toxicity assessment to derive site-specific estimates of potentially carcinogenic and non-carcinogenic risks resulting from both current and reasonably foreseeable future potential human exposures to COPCs. The results of the risk characterization will be used to identify constituents of concern (COCs), which are the subset of those COPCs whose risks result in an exceedance of the target risk range of 10^{-6} to 10^{-4} for potential carcinogens and a target Hazard Index of 1 for non-carcinogens (that act on the same target organ) (USEPA, 1990; 1991b);
- Uncertainty Evaluation - Within any of the steps of the risk assessment process described above, assumptions must be made due to a lack of absolute scientific knowledge. Some of the assumptions are supported by considerable scientific evidence, while others have less support. The assumptions that introduce the greatest amount of uncertainty in this risk evaluation will be discussed in the Risk Characterization section of the HHRA report; and
- Summary and Conclusions - Section 6 discusses the summary and conclusions section of the baseline HHRA report.

2 Data Evaluation and Hazard Identification

Analytical data collected in support of the RI will be compiled and tabulated in a database for statistical analysis. The steps used to summarize the data for use in identifying COPCs are discussed here. The additional steps used to summarize the data for identifying exposure point concentrations (EPCs) are presented in Section 4.

Data for samples and their duplicates will be averaged before summary statistics are calculated, such that a sample and its duplicate are treated as one sample for calculation of summary statistics (including maximum detection and frequency of detection) (USEPA, 1989a). Where both the sample and the duplicate are not detected, the resulting values used in the statistics will be the average of the sample-specific quantitation limits (SSQLs). Where both the sample and the duplicate are detected, the resulting values will be the average of the detected results. Where one of the pair is reported as not detected and the other is detected, the detected concentration will be used.

Summary statistic tables will include the following statistics:

- Frequency of Detection: The frequency of detection (FOD) is reported as a ratio of the number of samples reported as detected for a specific constituent and the total number of samples analyzed. The total number of samples reflects the averaging of duplicates discussed above;

- Minimum Detected Concentration: This is the minimum detected concentration for each constituent/area/medium combination, after duplicates have been averaged;

- Maximum Detected Concentration: This is the maximum detected concentration for each constituent/area/medium combination, after duplicates have been averaged; and

- Mean Detected Concentration: This is the arithmetic mean concentration for each constituent/area/medium combination, after duplicates have been averaged, based on detected results only.

<u>COPC Selection</u>

The compiled data will be compared to appropriate screening levels to identify COPCs for inclusion in the quantitative risk assessment. The COPC selection process will be conducted on a site-wide basis. Chemicals that are detected at least once in a medium will be sequentially screened as detailed below. The COPC screening steps are as follows:

1. *Identify chemicals that are essential nutrients*. Chemicals identified as essential nutrients (i.e., calcium, iron, magnesium, sodium and potassium) will not be included as COPCs (USEPA, 1989a).

2. *Evaluate frequency of detection*. For data sets with at least 20 samples, a chemical detected in 5% or fewer of the samples will not be retained as a COPC (USEPA, 1989a) provided samples with detected concentrations do not indicate the presence of potential hot spots.

3. *Compare maximum concentrations to health risk-based screening levels*. A chemical with a site-wide maximum detected concentration above its screening level will be retained as a COPC.

   - *Sediment/Wetland soils*. USEPA Regional Screening Levels (RSLs, USEPA, 2012a) for residential soil will be used to select COPCs in sediment and/or wetland soils adjacent to the river. Because residential soil RSLs are overly conservative for the selection of COPCs for river sediment/wetland soil with which humans may come into contact only occasionally, the residential soil RSLs for carcinogens will be multiplied by ten, which is equivalent to a 10^{-5} cancer risk level. The residential soil RSLs for non-carcinogens are set at a hazard quotient of 1, and will not be modified for COPC selection.
   - *Surface water*. USEPA RSLs for tap water will be used to select COPCs in surface water. Because tap water RSLs are overly conservative for the selection of COPCs for occasional exposures to surface water (e.g., recreational), the tap water RSLs will modified consistent with sediment (carcinogens will be multiplied by ten, non-carcinogens will be used as is).
   - *Fish tissue*. Recent fish tissue data available from other studies will be evaluated in conjunction with the USEPA Region 3 Risk Based Screening Levels for fish (USEPA, 2012b) and will be used to select COPCs in fish tissue.
   - *Groundwater-to-surface water discharge*. Default and/or site-specific dilution factors will be applied to groundwater data from nearshore monitoring wells to estimate surface water concentrations at the point of discharge to the river. Concentrations above surface water screening values may be considered indicative of a potential for human health risks and may warrant further evaluation through Site-specific modeling efforts.

Tables documenting the COPC selection process for each medium will be presented in the baseline HHRA report, with the rationale for inclusion or elimination clearly stated. To the extent that sufficient background data are available, COPCs that appear to be influenced by regional urban background concentrations will be flagged in the screening process for further consideration in the risk characterization (USEPA 2002c,d).

Dose-Response Assessment

The purpose of the dose-response assessment is to identify the types of adverse health effects a constituent may potentially cause, and to define the relationship between the dose of a constituent and the likelihood of an adverse effect (response). Adverse effects are defined by USEPA as potentially carcinogenic or noncarcinogenic (i.e., potential affects other than cancer). The USEPA has defined the dose-response values for potentially carcinogenic effects as Cancer Slope Factors (CSFs) or Unit Risk Factors (URFs), and dose-response values for noncarcinogenic effects as Reference Doses (RfDs) or Reference Concentrations (RfCs). Subchronic RfDs and RfCs apply to substantially less than lifetime exposures (USEPA, 1989a), generally exposures less than seven years in duration (i.e., 1/10th of the average lifetime of 70 years). Chronic RfDs and RfCs apply to exposures greater than seven years duration.

The USEPA's guidance for sources of human health dose-response values in risk assessment will be followed in selecting dose-response values (USEPA, 2003). Sources of published dose-response values that may be used in the HHRA include USEPA's Integrated Risk Information System (IRIS) (USEPA, 2012c) and the USEPA National Center for Environmental Assessment (NCEA) in Cincinnati, Ohio. In accordance with USEPA (2003), when dose-response values are not available from those sources, other sources of information may include California Environmental Protection Agency (CalEPA), the Agency for Toxic Substances and Disease Registry (ATSDR), and the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997).

Dose-response values used in the risk assessment will be presented in tabular format. For each constituent, the table will present the Chemical Abstracts Service (CAS) registry number, dose-response value, source, study animal, study method, and where appropriate, target organ, critical effect, uncertainty factors, and confidence level.

Dose-response values are available for oral and inhalation exposures. Oral dose-response values will be used to evaluate dermal exposures using appropriate adjustment factors from USEPA (2004). Inhalation dose-response values are not expected to be relevant or complete exposure pathways for the Site. For carcinogens presumed to act via a mutagenic mode of action, dose-response values are generally based on the linearized multistage model, which assumes that cancer risks are linear in the low-dose region (USEPA 2005b,c). Consistent with the Cancer Guidelines and Supplemental Guidance for Assessing Susceptibility for Early-Life Exposure to Carcinogens (USEPA 2005c), the application of age-dependent adjustment factors for chemicals with a mutagenic mode of action will be used in the calculation of risk from specific chemicals, such as PAHs. The potential contribution to lifetime risk from early life exposures to PAHs and associated chemicals with mutagenic modes of action will be discussed in the risk characterization and uncertainty sections of the report.

In the event that polychlorinated biphenyls (PCBs), dioxins and furans (PCDDs/PCDFs), mercury, and/or lead are identified as COPCs, the following approaches will be used to assess these compounds in the HHRA.

Polychlorinated Biphenyls

Risks from potential exposures to PCBs will be calculated using the most current guidance available from USEPA. Current USEPA guidance provided in IRIS (USEPA, 2012c) provides three tiers of cancer slope factors (CSFs) for evaluating potential carcinogenic effects of total PCBs (sum of congeners or Aroclors): 1) high risk and persistence, 2) low risk and persistence, and 3) lowest risk and persistence. The choice of slope factor for use depends on the medium of exposure and PCB chlorine content (USEPA, 2012). Total PCB concentrations will be calculated by summing individual detected congener concentrations (or detected Aroclors if congener data are not available). Non-cancer risks from potential exposures to total PCBs will be calculated using an appropriate RfD for a PCB mixture (based on Aroclor 1016 or Aroclor 1254).

Dioxins and Furans (PCDDs/PCDFs)

Because dioxins and furans occur in complex mixtures, the toxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), by far the most extensively studied of the group, is used as a reference for the other members of this family of chlorinated compounds. Based on their ability to bind to the Ah receptor, seven dioxin and 10 furan congeners are assumed to have a mechanism of toxicity similar to that of 2,3,7,8- TCDD. Toxic equivalency factors (TEFs) have been developed by WHO (Van den Berg, et al., 2006) to equate the toxicity of each dioxin-like congener to that of 2,3,7,8-TCDD. TEFs have been identified for 17 dioxins and furans, ranging from 0.0003 to 1, as shown in Table 1. In December 2010, USEPA published guidance that adopts the 2005 WHO mammalian TEFs for HHRA, but does not address specific risk assessment applications of TEFs (USEPA, 2010c).

Table 1: Toxic Equivalency Factors (TEFs) for Dioxin-Like Compounds

Compound	**WHO 2005 TEF**
Chlorinated dibenzo-p-dioxins	
2,3,7,8-TCDD	1
1,2,3,7,8-PeCDD	1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.0003
Chlorinated dibenzofurans	
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.03
2,3,4,7,8-PeCDF	0.3

Compound	WHO 2005 TEF
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
OCDF	0.0003

Source: USEPA, 2010c.

By multiplying the concentration of each dioxin-like congener in an environmental sample by its TEF, and summing the results, a toxic equivalent concentration (TEQ) can be calculated for that sample; alternatively the TEF can be applied to the TCDD oral CSF to derive congener-specific CSFs. The California EPA Toxicity Criteria Database lists an oral CSF of 1.3E+05 $(mg/kg\text{-}day)^{-1}$ for TCDD (CA EPA, 2009). This is the CSF used by USEPA to derive the most recent (May 2012) cancer Regional Screening Level (RSL) for TCDD (USEPA, 2012a). For evaluating potential noncarcinogenic effects of dioxin, USEPA's oral reference dose of 7.0E-10 mg/kg-day will be used (USEPA, 2012c). The implications of using the dioxin RfD will be discussed in the uncertainty analysis, including issues associated with background exposures. The background daily TEQ intake for an adult is estimated to be on the order of 6E-10 mg/kg-day, mostly from food (Lorber et al., 2009).

Mercury

Mercury is considered by USEPA to be a noncarcinogen (USEPA, 2012c). Reference doses are available for a number of forms of mercury, including elemental mercury, mercuric chloride, and methyl mercury. The RfD for mercuric chloride will be used to evaluate the total mercury data, and the RfD for methyl mercury will be used to evaluate the methyl mercury data. Mercury in sediment is most likely to exist in the salt form; therefore, the RfD for mercuric chloride is appropriate. The site-specific data on the fraction of methyl mercury comprising total mercury in sediment and fish tissue will be considered in determining appropriate mercury dose-response values.

Lead

Potential risks from lead are not assessed using the RfD or CSF approach (USEPA, 2012c). Therefore, lead in sediment or surface water will be evaluated using available pharmacokinetic models, as appropriate (e.g., Integrated Exposure Uptake Biokinetic (IEUBK) Model and Adult Lead Model (ALM) [http://www.epa.gov/superfund/lead/products]).

3 Exposure Assessment

The purpose of the exposure assessment is to estimate the magnitude and frequency of potential human exposure to the COPCs retained for quantitative evaluation in the baseline HHRA. The first step in the exposure assessment process is the characterization of the setting of the Study Area. Current and reasonably foreseeable potential future uses and potential receptor populations (i.e., those who may contact the impacted environmental media of interest) are then identified. Potential exposure scenarios appropriate to current and reasonably foreseeable potential future uses and receptors are then developed. Those potential exposure pathways for which COPCs are identified and are judged to be complete will be evaluated quantitatively in the baseline risk assessment. Reasonable maximum exposure (RME) assumptions, and central tendency exposure (CTE) assumptions based on appropriate USEPA guidance will be employed in the quantitative risk assessment. The RME provides an estimate of the upper range of exposure in a population (the 90th percentile or greater of expected exposure) expected to occur under both current and future land use conditions, and is based on a combination of the upper-bound and central estimates of exposure parameters. It is not appropriate to set all RME exposure factor inputs to upper-percentile values, inasmuch as the resulting exposure estimates may exceed RMEs for the population of interest (USEPA 2004). The intent of the RME is to estimate a conservative exposure case that is above the average case but still within the range of possible exposures (USEPA 1989a, 1992b). The CTE uses average exposure parameters to calculate the average exposure of an individual. Both RME and CTE analyses will be presented for each exposure scenario.

Consistent with USEPA's guidance, the exposure assessment will rely on site-specific approaches and assumptions to the extent possible. Use of default or surrogate assumptions as a basis for remedial decision-making is inconsistent with USEPA guidance documents, which stress the importance of using data that represent the characteristics of the local population(s) and site (USEPA 1989a, b, 1998, 2000a, 2011a). Due to the site-specific nature of exposure assumptions for the fish ingestion pathway, site-specific data will be used to the extent possible. Since site-specific data gathering is ongoing, specific exposure parameter values are not provided in this document, but will be presented in a separate Technical Memorandum for discussion with the regulatory agencies. Relevant USEPA sources of exposure information, including the updated Exposure Factors Handbook (USEPA 2011a) and Child-Specific Exposure Factors Handbook (USEPA, 2008), will also be used in the identification of appropriate RME and CTE exposure assumptions for the HHRA.

Identification of Potential Exposure Scenarios

Exposure scenarios are developed on the basis of the HHRA CSM summarized in Section 3 of the RI/FS Work Plan. The following potentially complete exposure scenarios are identified as warranting evaluation in the baseline HHRA:

Worker

It is assumed that an adult worker may be exposed to COPCs via direct contact (incidental ingestion and dermal contact) with surface sediment and surface water while working along the banks of the Anacostia River adjacent to the Site.

Recreational Receptor

It is assumed that recreational receptors may be exposed to COPCs via direct contact (incidental ingestion and dermal contact) with surface sediment and surface water while wading or swimming in the Anacostia River. The age of the recreational receptor most likely to visit the river is assumed to be an older child/teenager. An adult accompanied by a young child is also assumed to occasionally visit the river.

Recreational Angler

Despite the presence of an advisory warning against the consumption of certain species of fish from the Anacostia and Potomac Rivers, it is assumed that a recreational angler visits the Anacostia River to fish and consumes his/her catch. It is assumed that the recreational angler may be exposed to COPCs via 1) direct contact (incidental ingestion and dermal contact) with sediment and surface water, and 2) ingestion of fish. The ages of the recreational angler is assumed to be an adult and older child. It is assumed that the adult angler brings home fish that may be consumed by a young child.

Quantification of Potential Exposures

To estimate the potential risk to human health that may be posed by exposures to COPCs, it is first necessary to estimate the potential exposure dose of each COPC. The exposure dose is estimated for each constituent via each exposure pathway by which a receptor is assumed to be exposed. Exposure dose equations combine the estimates of constituent concentration in the environmental medium of interest with assumptions regarding the type and magnitude of each receptor's potential exposure to provide a numerical estimate of the exposure dose. The exposure dose is defined as the amount of COPC taken into the receptor and is expressed in units of milligrams of COPC per kilogram of body weight per day (mg/kg-day).

Exposure doses are defined differently for potential carcinogenic and noncarcinogenic effects. The Chronic Average Daily Dose (CADD) is used to estimate a receptor's potential intake from exposure to a COPC with noncarcinogenic effects. According to USEPA (1989a), the CADD should be calculated by averaging the dose over the period of time for which the receptor is assumed to be exposed. Therefore, the averaging period is the same as the exposure duration.

For COPCs with potential carcinogenic effects, however, the Lifetime Average Daily Dose (LADD) is employed to estimate potential exposures. In accordance with USEPA (1989a) guidance, the LADD is calculated by averaging exposure over the receptor's assumed lifetime (70 years). Therefore, the averaging period is assumed to be the same as the receptor's lifetime.

The standardized equations for estimating a receptor's average daily dose (both lifetime and chronic) are presented below, followed by descriptions of receptor-specific exposure parameters and constituent-specific parameters.

3.1 Estimating Potential Exposures to COPCs in Sediment

The following equations are used to calculate the estimated exposures to sediment.

Average Daily Dose (Lifetime and Chronic) Following Incidental Ingestion of Sediment/Soil (mg/kg-day):

$$ADD = \frac{CS\ x\ SIR\ x\ FI\ \ x\ EF\ \ x\ ED\ xAAF_o\ xCF}{BWxAT}$$

where:

ADD	=	Average Daily Dose (mg/kg-day)
CS	=	Sediment Concentration (mg/kg sediment)
SIR	=	Sediment Ingestion Rate (mg sediment/day)
FI	=	Fraction Ingested from Potentially Impacted Source (unitless)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (year)
AAF_o	=	Oral Sediment/Absorption Adjustment Factor (constituent-specific)
CF	=	Unit Conversion Factor (kg sediment/10^6 mg sediment/soil)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

Average Daily Dose (Lifetime and Chronic) Following Dermal Contact with Sediment (mg/kg-day):

$$ADD = \frac{CS\ x\ SA\ x\ AF\ x\ FI\ x\ EF\ x\ ED\ x\ DAF\ \ x\ CF}{BWxAT}$$

where:

ADD = Average Daily Dose (mg/kg-day)

CS = Sediment/Soil Concentration (mg/kg sediment)

SA = Exposed Skin Surface Area (cm^2/day)

AF = Sediment/Soil to Skin Adherence Factor (mg sediment/cm^2)

FI = Fraction Contacted from Potentially Impacted Source (unitless)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (year)

DAF = Dermal Absorption Fraction (constituent-specific) (unitless)

CF = Unit Conversion Factor (kg sediment/soil/10^6 mg sediment)

BW = Body Weight (kg)

AT = Averaging Time (days)

3.2 Estimating Potential Exposures to COPCs in Fish Tissue

The equation used to estimate a receptor's potential exposure via fish consumption is:

Average Daily Dose (Lifetime and Chronic) Following Fish Consumption (mg/kg-day):

$$ADD = \frac{CF\ x\ IR\ x\ \ FI\ \ x\ (1 - Loss)\ x\ AAF\ \ x\ EF\ x\ ED}{AT\ x\ BW}$$

where:

ADD = Average Daily Dose (mg/kg-day)

CF = Concentration in Fish Tissue (mg/kg)

IR = Ingestion Rate (kg/day)

FI = Fraction ingested from Source

Loss = Preparation/cooking loss (unitless)

AAF_o = Oral Absorption Adjustment Factor (constituent-specific)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

AT	=	Averaging Time (days)
BW	=	Body Weight (kg)

3.3 Estimating Potential Exposures to COPCs in Surface Water

Chronic Daily Intake Following Ingestion of Surface Water (mg/kg-day):

$$CDI = \frac{CW \times IR \times EF \times ED}{BW x AT}$$

where:

CDI	=	Chronic Daily Intake (mg/kg-day)
CW	=	Water concentration (mg/L)
IR	=	Water ingestion rate (L/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (year)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

The equation used to estimate a receptor's potential exposure via dermal contact with surface water is as follows.

$$CDI = \frac{DA_{event} \times EV \times EF \times ED \times SA}{BW \times AT}$$

where:

CDI	=	Chronic Daily Intake (dermally absorbed dose) (mg/kg-day)
DAevent	=	Absorbed Dose per Event (mg/cm^2-event)
SA	=	Surface Area (cm^2)
EV	=	Event Frequency (events/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (years)

The calculation of the dose absorbed per unit area per event (DA_{event}) is as follows for inorganics or highly ionized organics:

$$DA_{event} = CW \times PC \times ET \times CF$$

where:

DA_{event}	=	Absorbed Dose per Event (mg/cm^2-event)
CW	=	Concentration in Water (mg/L)
PC	=	Permeability Constant (cm/hr)
ET	=	Exposure Time (hr/event)
CF	=	Conversion factor (L/1000 cm^3)

The calculation of DA_{event} is as follows for organics:

If ET $\leq$ t*, then: $$DA_{event} = 2\,FA \times PC \times CW \times CF \sqrt{\frac{6\,T \times ET}{\pi}}$$

If ET > t*, then $$DA_{event} = FA \times PC \times CW \times CF \times \left[\frac{ET}{1+B} + 2T\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]$$

where:

DA_{event}	=	Absorbed Dose per Event (mg/cm^2-event)
FA	=	Fraction Absorbed water (dimensionless)
PC	=	Permeability Constant (cm/hour)
CW	=	Concentration in Water (mg/L)
T	=	Lag Time per event (hr/event)
ET	=	Exposure Time (hr/event)
t*	=	Time to Steady State (hr) = 2.4T
B	=	Dimensionless ratio of the PC of a chemical through the stratum corneum relative to its permeability constant across the viable epidermis
CF	=	Conversion Factor (L/1000 cm^3)

<u>Parameters for Water Dermal Dose Calculation</u>

The estimation of exposure doses resulting from incidental dermal contact with surface water requires the use of a dermal permeability constant (PC) in units of centimeters per hour (cm/hr). This method assumes that the behavior of constituents dissolved in water is described by Fick's Law. In Fick's Law, the steady-state flux of the solute across the skin ($mg/cm^2/hr$) equals the permeability constant (PC cm/hr) multiplied by the concentration difference of the solute across the membrane (mg/cm^3). This approach is discussed by USEPA (USEPA, 1989a; 2004).

The PC values will be derived from USEPA (2004) Exhibit B-3. For the COPCs lacking PCs in the USEPA guidance, PCs will be calculated using the USEPA algorithms. In addition to PCs, several other parameters are necessary to calculate dermal dose from exposure to organic compounds in water. These parameters will also obtained from USEPA (2004), Exhibit B-3, and include the ratio of the permeability coefficient of a chemical through the stratum corneum relative to its permeability coefficient across the viable epidermis (B, dimensionless), lag time (T, hours/event), and time to steady state (t*, hours). Parameters for constituents not available from USEPA (2004) will be calculated. Note that the spreadsheets that accompany RAGS Part E (USEPA, 2004) (available on USEPA's website http://www.epa.gov/oerrpage/superfund/programs/risk/ragse/) will be used to obtain the parameters, as the printed version often shows 0.0 for small values.

3.4 Constituent-Specific Parameters

The dermal and oral absorption and preparation/cooking loss parameters identified in the equations presented above are chemical-specific, and are described below.

Dermal Absorption Fractions

The dermal absorption fraction (DAF) accounts for lower absorption through the skin. USEPA chemical-specific DAFs will be used where available (USEPA, 2004). DAFs are available for PCBs and some of the inorganic COPCs. For the inorganics lacking DAFs in USEPA (2004), the default value of 0.001 (0.1%) for inorganic chemicals recommended by USEPA Region 4 (2000b), or other appropriate default DAFs, will be used.

Oral Absorption Adjustment Factors

Absorption adjustment factors (AAFs) are used in risk assessment to account for absorption differences between humans exposed to substances in environmental situations and experimental animals in the laboratory studies used to derive dose-response values. Support for use of AAFs is provided in USEPA guidance (1989a, 1992b). The AAF is the ratio between the estimated human absorption factor for the specific medium and route of exposure, and the known or estimated absorption factor for the laboratory study from which the dose-response value was derived.

$$AAF = \frac{\text{(fraction absorbed in humans for the environmental exposure)}}{\text{(fraction absorbed in the dose - response study)}}$$

The use of an AAF allows the risk assessor to make appropriate adjustments if the efficiency of absorption between environmental exposure and experimental exposure is known or expected to differ because of physiological effects and/or matrix or vehicle effects. When the dose-response curve is based on administered dose data, and if it is estimated that the fraction absorbed from the site-specific exposure is the same as the fraction absorbed in the laboratory study, then the AAF is 1. In the absence of detailed toxicological information on every constituent, it has been common practice for risk assessors to use a default oral AAF value of 1. However, use of AAFs in standard risk assessment calculations can provide more accurate and more realistic estimates of potential human health risk. Representative and appropriate AAFs based on available toxicological data will be developed to the extent practicable. The derivation of any non-default oral AAFs used in the HHRA will be provided in an appendix to the HHRA report. In the absence of appropriate data, a default AAF of 1 will be used.

Preparation/Cooking Loss

Preparation and cooking procedures can modify the amount of COPC ingested by fish consumers (USEPA, 2000a). Numerous studies have demonstrated the loss of chemicals such as PCBs from fish tissues during preparation and cooking (e.g., Bayen et al. 2005, Hori et al., 2005, Zabik et al. 1994, 1995a, 1995b, 1996, Moya 1998, Skea et al 1979), many of which are summarized in USEPA 2000a. Incorporating a modification factor to account for preparation and cooking loss requires information on methods used to prepare and cook the angler's catch, and the extent to which the COPC concentrations measured in the tissue types analyzed are likely to decrease based on these cooking methods. Cooking loss factors have been included in the angler scenarios for several large sediment site HHRAs, including the Housatonic River (Weston, 2005), Lower Fox River (RETEC, 2002), and Kalamazoo River (CDM, 2003). Preparation/cooking loss factors representative of site-specific conditions will be included in the baseline HHRA provided the supporting data needed are available, as described below.

Available data on catch preparation and cooking practices, as well as tissue type, will be summarized for species relevant to the Anacostia River. In addition, the available literature will be reviewed to identify studies that provide data on species, preparation and cooking methods, and chemical groups relevant to the Site. Data from these studies will be summarized, including observed ranges and means of cooking loss estimates. Based on this information, preparation/cooking loss estimates will be developed for use in the HHRA.

3.5 Calculation of Exposure Point Concentrations

Exposure points are located where potential receptors may contact COPCs at or from the Site. The concentration of COPCs in the environmental medium that receptors may contact must be estimated in order to determine the magnitude of potential exposure.

The exposure point concentration (EPC) will be defined as the 95% upper confidence level (UCL) (USEPA 2002a) for the RME scenario. UCLs will be calculated using USEPA's ProUCL Version 4.1.01 (USEPA, 2011b, 2010a,b). The UCL recommended by ProUCL will be used unless determined to be inappropriate based on a statistical review, or if it exceeds the maximum detected concentration (USEPA 1989a). The maximum will be used where the UCL exceeds the maximum, and the uncertainty associated with the corresponding risk estimates will be discussed in the uncertainty section of the HHRA.

Mean or median concentrations will be used to represent the CTE scenario EPCs (use of the mean where data follow a normal distribution, and the median where no distribution is discernible).

For sediment, data from samples collected near the shore, where the potential for direct contact is greatest, will be used to estimate EPCs for the sediment exposure pathways. The need to segment the river into separate exposure areas for the baseline HHRA will be evaluated once RI data collection is complete.

For fish, available data will be used where possible to estimate EPCs. Relevant and appropriate data from existing studies will be considered for use in developing site-specific tissue EPCs. If adequate fish tissue data are not available, it may be necessary to predict tissue concentrations from surface water and/or sediment data using bioaccumulation modeling. The basis for any modeled fish tissue concentrations will be documented in the HHRA.

4 Risk Characterization

The purpose of the risk characterization is to provide estimates of the potential risk to human health from exposure to COPCs. The results of the exposure assessment are combined with the results of the dose-response assessment to derive quantitative estimates of risk. Each exposure pathway for each receptor will be evaluated for potential carcinogenic or non-carcinogenic effects.

4.1 Carcinogenic Risk Characterization

The purpose of carcinogenic risk characterization is to estimate the upper-bound likelihood, over and above the background cancer rate, that a receptor will develop cancer in his or her lifetime as a result of exposure to a constituent in an environmental medium. This likelihood is a function of the dose of a constituent (described in the Exposure Assessment) and the CSF (described in the Dose-Response Assessment) for that constituent. The American Cancer Society (ACS) estimates that the lifetime probability of contracting cancer in the U.S. is 1 in 2 for men and 1 in 3 for women (ACS, 2012). The Excess Lifetime Cancer Risk (ELCR) associated with estimated exposures at a site is the likelihood, over and above the background cancer rate, that an individual will develop cancer in his or her lifetime due to those site exposures. The cancer risk is expressed as a probability (e.g., 10^{-6}, or one in one million). An ELCR of 10^{-6} indicates that an individual would have a 1 in one million chance of developing cancer in addition to the 1 in 2 or 1 in 3 background chance estimated by the ACS. The relationship between the ELCR and the estimated LADD of a constituent may be expressed as:

$$ELCR = 1-e^{-(CSF \times LADD)}$$

If the product of the CSF and the LADD is much greater than 1, the ELCR approaches 1 (i.e., 100 percent probability). If the product is less than 0.01 (one chance in 100), the equation can be closely approximated by:

$$ELCR = LADD\ (mg/kg\text{-}day) \times CSF\ (mg/kg\text{-}day)^{-1}$$

The product of the CSF and the LADD is unitless, and provides an upper-bound estimate of the potential carcinogenic risk associated with a receptor’s exposure to a constituent or an exposure pathway for each receptor. Current USEPA risk assessment guidelines assume that cancer risks are additive or cumulative. Pathway- and area-specific risks are summed to estimate the total potential cancer risk for each receptor. A summary of the total cancer risks for each receptor group will be presented in this section of the HHRA.

USEPA has established target risk levels under the National Contingency Plan (NCP) (USEPA, 1990). Target risk levels refer to levels of cancer risk or hazard indices that are deemed acceptable by the USEPA or other regulatory agencies. These are levels below which the potential for adverse effects to humans are assumed to be negligible or inconsequential. The NCP establishes a target cancer risk range of 10^{-6} to 10^{-4} and a target hazard index of less than or equal to one (USEPA, 1990). The USEPA subsequently clarified that, "Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted, unless there are adverse environmental impacts" (USEPA, 1991b).

Thus, potential risks will be compared to the USEPA range of 10^{-6} to 10^{-4}. COPCs that cause exceedance of the risk range will be identified as COCs.

4.2 Non-carcinogenic Risk Characterization

The potential for adverse non-carcinogenic health effects is estimated for each receptor by comparing the CADD for each COPC with the RfD for that COPC. The resulting ratio, which is unitless, is known as the Hazard Quotient (HQ) for that constituent. The HQ is calculated using the following equation:

$$HQ = \frac{CADD\ (mg/kg\text{-}day)}{RfD\ (mg/kg\text{-}day)}$$

The target HQ is defined as an HQ of less than or equal to one (USEPA, 1989a). When the HQ is less than or equal to one, the RfD has not been exceeded, and no adverse non-carcinogenic effects are expected. If the HQ is greater than one, there may be a potential for adverse non-carcinogenic health effects to occur; however, the magnitude of the HQ cannot be directly equated to a probability or effect level.

The total Hazard Index (HI) is calculated for each exposure pathway by summing the HQs for each individual constituent. The total HI will be calculated for each potential receptor by summing the HIs for each pathway associated with the receptor. If the total HI is greater than one for any receptor, a more detailed evaluation of potential non-carcinogenic effects based on specific target organs/health endpoints will be performed (USEPA, 1989a).

A summary of HIs for each receptor group will be presented and compared to the USEPA’s target HI of 1. If the cumulative target organ HIs for a receptor are less than 1, then no further evaluation or action is warranted based on potential non-carcinogenic risks.

Using the results of the RME and CTE risk calculations, chemicals of concern (COCs) will be identified, which are those COPCs that cause exceedance of the non-cancer target HI of 1 per target organ.

4.3 Risk Characterization for Lead

Exposure and risk characterization for lead in environmental media will be evaluated using available pharmacokinetic models, as appropriate (e.g., IEUBK Model and ALM [http://www.epa.gov/superfund/lead/products]).

4.4 Risk Assessment Refinement

The baseline HHRA will be conducted using reasonable but conservative exposure and dose-response assumptions, and will follow a deterministic (i.e., point estimate) approach. The risk estimates may be further refined by using, for example: site-specific bioavailability factors, site-specific exposure data, or probabilistic (or Monte Carlo) analysis. The potential contribution of background conditions will also be considered in the evaluation of risk assessment results. Use of such refinements, such as a probabilistic risk assessment, will allow the potential risks to be put in perspective and will provide information that the risk manager may use to more accurately characterize risks on a location-specific basis and to communicate the nature of the risks. The need for refinements to the risk assessment process will be explored pending the outcome of the initial deterministic risk assessment.

4.5 Uncertainty Analysis

Uncertainty is introduced into the risk assessment throughout the process when an assumption is made. In accordance with USEPA guidance (USEPA, 1989a), the uncertainty associated with each step of the risk assessment will be discussed qualitatively in this section of the report.

There are many potential sources of uncertainty in the risk assessment process; some are more important than others. The major areas of uncertainty include: the quality of the analytical data, assumptions about the frequency, duration, and magnitude of exposure, the receptors identified, and the availability and accuracy of dose-response data. The uncertainties will be discussed qualitatively, including steps taken to compensate for uncertainty, and the impact on the risk assessment results.

5 Summary and Conclusions

The summary and conclusions of the baseline HHRA will be summarized. The receptor/exposure scenarios that result in unacceptable risks, if any, will be identified, and constituents of concern (COCs) will be presented.

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Appendix F

Ecological Risk Assessment Work Plan

Contents

List of Tables

1 Introduction

The results of the waterside field investigation will be used to evaluate the potential for ecological risks associated with exposure to environmental media within or along the Anacostia River adjacent to the Site. The ecological risk assessment (ERA) will be conducted according to the general tiered approach and methodology provided by the USEPA *Ecological Risk Assessment Guidance for Superfund (ERAGS): Process for Designing and Conducting Ecological Risk Assessment, Interim Final* (USEPA, 1997), *Guidelines for Ecological Risk Assessment* (USEPA, 1998), and *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (USEPA, 2001).

Each successive tier of ERA requires more detailed and quantitative data analysis and interpretation. Conducting assessments in a tiered, step-wise manner allows the risk assessor and risk manager to maximize the use of available information and sampling data, while providing the opportunity to reduce the uncertainties inherent in the ERA process through the use of focused supplemental data collection to fill key data gaps identified in the previous tier of the assessment, as necessary.

In accordance with the USEPA guidance and process documents, the principal components of the ERA will include:

- **Problem Formulation**: In this phase, the objectives of the ERA are defined, and a plan for characterizing and analyzing risks is determined. Available information regarding stressors and specific sites is integrated. Products generated through problem formulation include assessment endpoints and CSMs;
- **Risk Analysis**: During the risk analysis phase of work, data are evaluated to characterize potential ecological exposures and effects; and
- **Risk Characterization**: During risk characterization, exposure and stressor response profiles are integrated through risk estimation. Risk characterization also includes a summary of uncertainties, strengths, and weaknesses associated with the risk assessment.

These three components are conceptually sequential. However, the risk assessment process is frequently iterative, and new information brought forth during the risk characterization phase, for instance, may lead to a review of the problem formulation phase, or additional data collection and analysis. This work plan describes the general approach for each of these ERA components, as follows:

- Section 2 describes the Problem Formulation, which includes a summary of the Field Reconnaissance Site Visit, and the identification of ecological receptors and exposure pathways for the development of the assessment endpoints and the CSM;
- Section 3 describes the Risk Analysis, which includes a summary on data treatment, and the plan for risk analyses of warm water fish, benthic invertebrates, and vertebrate wildlife; and,
- Section 4 describes the Risk Characterization, which includes a discussion of how the results of the environmental risk analysis will be analyzed and interpreted and how uncertainty of the analysis will be evaluated.

The results of the ERA will be used to help inform the need for any additional evaluation and/or remedial action at the Site, and the Natural Resource Damage Assessment (NRDA).

2 Problem Formulation

Problem Formulation provides the framework for the ERA and serves to define the risk assessment objectives and the geographic area to be considered and identify the ecological receptors, exposure pathways and endpoints to be evaluated.

The risk assessment objective for this ERA is to evaluate whether or not populations of ecological receptors are potentially at risk due to exposure to Site-related chemical stressors within the Waterside Investigation Area. As indicated in **Figure 2** of the RI/FS Work Plan, the Waterside Investigation Area encompasses approximately 10 to15 acres of the Anacostia River and associated wetlands including approximately 1,500 linear feet to the south (approximately 1,000 ft south of the Benning Road Bridge) and 1,000 linear feet to the north of the Site's main storm water outfall area.

2.1 Field Reconnaissance

Pepco will conduct a site reconnaissance to develop a better understanding of the Study Area and surrounding conditions. Observations made during the Study Area reconnaissance will include a detailed evaluation of the habitat present within the Waterside Investigation Area. These observations will be critical for the identification of appropriate sampling locations and techniques, as well as the identification of target ecological receptors for the evaluation in the ERA.

In addition, available biological data for the Anacostia River in the vicinity of the Study Area will be reviewed to develop an understanding of the overall conditions. The United States Fish and Wildlife Service (USFWS), District Department of the Environment (DDOE), and National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service will be contacted to determine if any federally listed species or other sensitive receptors exist at or in the vicinity of the Study Area. This information will further support the selection of target ecological receptors and the identification of appropriate sampling locations and methodology.

2.2 Selection of Specific Receptors and Exposure Pathways

Potential ecological receptors occurring within the Study Area and potentially complete ecological exposure pathways will be evaluated. Each exposure pathway includes a potential source of COPC, an environmental medium, and a potential exposure route. In accordance with agency guidance, incomplete routes of exposure will not be evaluated in the ERA. This approach is used to focus the risk evaluation on exposure pathways that are considered to be potentially complete and for which there are adequate data pertaining to the receptors, exposure, and toxicity for completion of the risk analysis.

Exposure pathways for several groups of ecological receptors have been identified as potentially relevant. The available data suggest surface water, sediment, and fish tissue are the primary media of potential ecological concern within the Anacostia River. Potentially complete exposure pathways were determined to exist for fish, benthic macroinvertebrates, and piscivorous wildlife. Based on the available data and the CSM described in Section 3 of the RI/FS Work Plan, the ecological exposure pathways to be evaluated in the ERA include:

- Direct contact with surface water and sediment by warmwater fish;
- Direct contact with sediment by benthic macroinvertebrates; and
- Ingestion of contaminated prey items and abiotic media (i.e., surface water, sediment, and/or hydric soil) by selected vertebrate wildlife receptors (i.e., fish, piscivorous birds and mammals).

2.3 Selection of Biological Endpoints

Ecologically-based assessment endpoints and measures of effect were designed to evaluate potential ecotoxicological effects associated with exposure to identified COPC. According to USEPA (1998), assessment endpoints are formal expressions of the actual environmental value to be protected. They usually describe potential adverse effects to long-term persistence, abundance, or production of populations of key species or key habitats. Typically, assessment endpoints and receptors are selected for their potential exposure, ecological significance, economic importance, and/or societal relevance.

Because assessment endpoints often cannot be measured directly, a set of surrogate endpoints (measures of effect) are generally selected for ecological risk assessment that relate to the assessment endpoints and have measurable attributes (e.g., comparison of media concentrations to screening levels, results of food web models) (USEPA, 1997, 1998). These measures of effect provide a quantitative metric for evaluating potential effects of constituents on the ecosystem components potentially at risk. Since each measurement endpoint has intrinsic and extrinsic strengths and limitations, several measurement endpoints will be used to evaluate each assessment endpoint. Several of the endpoints considered below are based upon tissue residue data. For fish and other prey items, available data from published sources will be used where possible to estimate fish tissue residue concentrations in the Anacostia River. If adequate fish tissue data are not available, it may be necessary to predict tissue concentrations from surface water and/or sediment data using bioaccumulation modeling. The basis for any modeled fish tissue concentrations will be documented in the ERA.

The assessment endpoints and measures of effect selected for the ERA are:

- **Assessment Endpoint 1** – Protection and maintenance of fish communities in aquatic habitats within the Anacostia River typical of comparable upstream aquatic habitats with similar morphology, hydrology, and urban setting.
  - Measure of Effect 1a – Comparison of surface water concentrations to surface water screening values. Concentrations above the screening values are considered indicative of a potential for ecological risks.
  - Measure of Effect 1b – Comparison of groundwater concentrations collected from Nearshore monitoring wells to surface water screening values. Default and/or site-specific dilution factors will be applied to Nearshore monitoring well groundwater data to estimate surface water concentrations at the point of discharge to the river. Concentrations above the screening values may be considered indicative of a potential for ecological risks and may warrant further evaluation through Site-specific modeling efforts.
  - Measure of Effect 1c –Comparison of fish tissue COPC burdens to available critical body residue (CBR) thresholds and background tissue concentrations. In the absence of local fish tissue concentrations, levels of bioaccumulative COPCs in whole body fish tissue may be estimated using uptake factors.
- **Assessment Endpoint 2** – Protection and maintenance of freshwater benthic invertebrate populations in aquatic habitats within the Anacostia River typical of comparable aquatic habitats with similar morphology, hydrology, and urban setting.
  - Measure of Effect 2a – Comparison of sediment concentrations to low effect sediment screening values. Concentrations above the screening values are considered indicative of a potential for ecological risks.
  - Measure of Effect 2b – Characterization of bioavailability potential in sediment based on SEM and AVS relationships. SEM/AVS ratios greater than 1 in a sediment sample will be considered an indicator of potential bioavailability for divalent cationic metals. The SEM and AVS difference (SEM-AVS) and the influence of sediment organic carbon content will also be considered in this evaluation.
- **Assessment Endpoint 3** – Protection and maintenance of a piscivorous vertebrate wildlife community in aquatic and wetland habitats within the Anacostia River typical of comparable aquatic habitats with similar morphology, hydrology, and urban setting.
  - Measure of Effect 3a – Comparison of calculated potential daily exposure for avian and mammalian receptors from exposure to bioaccumulative COPCs in abiotic media (surface water, sediment,

and/or hydric soil) and ingestion of contaminated prey items to constituent-specific toxicity reference values (TRVs). Estimated doses above the TRVs are considered indicative of a potential for ecological risks.

2.4 Conceptual Site Model (CSM)

The end product of the problem formulation step is the development/refinement of the CSM. The CSM helps to describe the COPC origin, fate, transport, exposure pathways, and receptors of concern. A detailed description of the current preliminary CSM is found in Section 3 of the RI/FS Work Plan. The data collected to support the ERA will be used to further refine the CSM. The CSM will also consider the context of the Study Area within the anthropogenically impacted Anacostia River watershed. For instance, available Site data will be reviewed relative to readily available background data, sediment and surface water concentrations. Background concentrations of COPCs provide valuable insight into what toxic chemicals may be entering the Anacostia River from other sources and will be considered in the risk analysis. Collection of Site-specific background data and/or evaluation of background or reference condition data from other ongoing projects on the Anacostia River (e.g., Kenilworth Landfill, Poplar Point, and Washington Navy Yard) will be used to determine the background conditions.

3 Risk Analysis

The risk analysis phase of the ERA is based on the CSM developed in problem formulation. Risk analysis includes both the characterization of potential ecological exposure and effects. The ecological exposure assessment involves the identification of potential exposure pathways and an evaluation of the magnitude of exposure of identified ecological receptors. The ecological effects assessment describes the potential adverse effects associated with the identified COPC to ecological receptors and reflects the type of assessment endpoints selected. The data and methods that will be used to identify and characterize ecological exposure and effects are described in the following subsections.

3.1 Data Treatment

Exposure point concentrations (EPCs) will be estimated within each Site medium for each COPC in order to evaluate the selected ecological exposure pathways and receptors. These EPCs represent the range of media concentrations that ecological receptors may encounter. Average and maximum EPCs will be considered in the food chain evaluation and in the comparison of historic and recently collected concentration data against benchmarks. The maximum EPC will be the upper confidence limit (UCL) on the arithmetic mean, or the maximum when UCLs cannot be calculated due to data limitations (i.e., number of samples or number of detected results).

All analytical data (previous and future) will be compiled and tabulated in a database for statistical analysis. Data for samples and their duplicates will be averaged before summary statistics are calculated, such that a sample and its duplicate will be treated as one sample for calculation of summary statistics (including maximum detection and frequency of detection). Where both the sample and the duplicate are not detected, the resulting values are the average of the sample-specific quantitation limits (SSQLs). Where both the sample and the duplicate are detected, the resulting values are the average of the detected results. Where one of the pair is reported as not detected and the other is detected, the detected concentration is used.

USEPA's ProUCL Version 4.1.01 software (USEPA, 2011) will be used to calculate UCLs on the arithmetic mean and arithmetic means according to USEPA guidance (USEPA, 2002), using ProUCL and the Kaplan-Meier method where non-detects are present (using SSQLs and appropriate substitution methods), and simple arithmetic means of detected concentrations for datasets with no non-detects. The ProUCL recommended UCL (i.e., 95%, 97.5%, 99%) will be used as the selected UCL. Based on information presented in the ProUCL guidance (USEPA, 2010a,b) regarding minimum sample size and frequency of detection, UCLs and Kaplan-Meier means will be calculated where at least 10 samples and at least six detected results are available. While ProUCL version 4.1.01 recommends a minimum of 10 samples with six detected values in order to calculate reliable UCLs, the guidance recognizes that this may not always be possible due to resource or other restraints, and allows the user best professional judgment when determining the validity of the calculations.

The following summary statistics will be calculated:

- Frequency of Detection (FOD): The frequency of detection is reported as the number of samples reported as detected for a specific constituent and the total number of samples analyzed. The total number of samples reflects the averaging of duplicates discussed above;
- Maximum Detected Concentration: This is the maximum detected concentration for each constituent/area/medium combination, after duplicates have been averaged;
- Minimum Detected Concentration: This is the minimum detected concentration for each constituent/area/medium combination, after duplicates have been averaged;
- Mean Detected Concentration: This is the arithmetic mean concentration for each constituent/area/medium combination, after duplicates have been averaged, based on detected results only;
- Kaplan Meier Method Mean: When non-detects are present in the dataset, the mean concentrations will be derived by the program using appropriate SSQL substitution methods (USEPA, 2010a,b);
- UCL: The UCL recommended by ProUCL version 4.00.02. If more than one UCL is recommended by the program (i.e., 95%, 97.5%, 99%), the higher UCL will be selected;
- Maximum EPC: The lower of the selected UCL and the maximum detected concentration will be selected; and
- Average EPC: Arithmetic mean for datasets with no non-detects; Kaplan-Meier mean for datasets with non-detects. When the Kaplan-Meier mean cannot be calculated due to an insufficient number of detects, then the arithmetic mean of the detected results will be selected.

3.2 Warmwater Fish Community Risk Analysis

Fish may potentially be exposed to COPCs from direct contact with surface water and sediment and ingestion of sediment and contaminated food items. Studies conducted by the USFWS (Pinkney, et, al, 2002) found that brown bullhead catfish (*Ameiurus nebulosus*) collected from the Anacostia River in Washington, DC had high rates of both liver and skin tumors and that PAHs appear to play a role in tumor formation. As described in Section 2.3 above, three measures of effect will be used to evaluate the assessment endpoint developed for the warmwater fish community in the Waterside Investigation Area.

Potential risks to fish from COPC exposure in surface water will be evaluated through comparisons of site surface water and groundwater data with literature-derived toxicity thresholds. Surface water data will be collected in the vicinity of the Site and groundwater data from monitoring wells along the shoreline will be used to estimate surface water concentrations at the point of discharge to the river (e.g. default and/or site-specific dilution factors will be applied the the groundwater concentrations to represent surface water concentrations). The following surface water screening level sources will be used to evaluate exposure to surface water:

- DDOE Water Quality Standards (WQS) for the protection of freshwater aquatic life (DDOE, 2006);
- USEPA Region 3 Freshwater Screening Benchmarks (USEPA, 2006a); and
- Literature-based toxicological benchmarks (Suter & Tsao, 1996 and Buchman, 2008).

Potential risks to fish from COPC exposure via ingestion of sediment and contaminated food items will be evaluated through an assessment of fish tissue body burdens. Fish tissue data from recent studies will be evaluated for potential inclusion in the RI (e,g., studies such as Pinkney et al., 2001; Maryland Department of the Environment [MDE], 2012) will be reviewed to identify samples collected in the vicinity of the Site). Several different species have been collected from within the Potomac River (e.g., bluegill, carp, channel catfish, largemouth bass, American eel, bullhead, pumpkinhead sunfish, white sucker) and at least some tissue residue samples have been analyzed for PCBs, PAHs, metals, and pesticides (not all samples were analyzed for all parameters). For fish and other prey items, relevant and appropriate available data from published sources will be used where possible to estimate EPCs. If adequate fish tissue data are not available, it may be necessary to predict tissue concentrations from surface water and/or sediment data using bioaccumulation modeling. The basis for any modeled fish tissue concentrations will be documented in the ERA.

In order to evaluate the potential impact to the fish community due to exposure to COPCs in the Anacostia River within the Waterside Investigation Area, effects ranges for body burdens will be compiled from the literature and will represent tissue concentrations resulting from actual exposures that could potentially result in adverse biological effects. Values will be derived based on no observed adverse effects levels (NOAELs) and lowest observed adverse effects levels (LOAELs). NOAELs indicate a body residue concentration at which no adverse effects were observed and LOAELs indicate a body residue concentration at which adverse effects may begin to be observed. COPCs in fish tissue will be compared against the selected Critical Body Residue (CBRs).

3.3 Benthic Macroinvertebrate Community Risk Analysis

Benthic organisms (e.g., those living in sediment) may potentially be exposed to COPCs from direct contact with sediment. As described in Section 2.3 above, two measures of effect will be used to evaluate the assessment endpoint developed for the benthic macroinvertebrate community in the Waterside Investigation Area.

Potential risks to benthic macroinvertebrates from COPC exposure in sediment will be evaluated through comparisons of site data with the literature-derived toxicity thresholds. Sediment analytical chemistry analysis results will be compared to available low effect and probable effect sediment quality guidelines selected using a hierarchy of the following sources:

- Freshwater sediment values presented by the National Oceanic and Atmospheric Administration (NOAA) in Screening Quick Reference Tables (SQUIRT)(Buchman, 2008);
- USEPA Region 3 Freshwater Sediment Screening Benchmarks (USEPA, 2006b);
- USEPA Region 5 Ecological Screening Levels for sediment (USEPA, 2003); and
- Ontario Ministry of the Environment (OMOE) Provincial Sediment Quality Guidelines (Persaud et al., 1993)

To account for the potential for divalent metals bioavailability to be limited within the Study Area, SEM, AVS, and TOC will be measured in sediments collected as part of the proposed field effort. USEPA (2005) guidance on metals bioavailability evaluates possible binding of metals by both AVS and organic matter. Therefore, data collected as part of the proposed field program will be evaluated on a sample-by-sample basis using the following scale to evaluate whether or not the organic carbon binding phase (represented as fraction organic carbon or f_{oc}), in conjunction with the AVS, is affecting the bioavailability of divalent metals in sediments:

- If the (∑SEM-AVS)/foc excess exceeds 3000 µmol/goc, the sediments are presumed to be "likely to be toxic";
- If the (∑SEM-AVS)/foc excess is between 130 and 3,000 µmol/goc, predictions of effects are uncertain; and
- If the (∑SEM-AVS)/foc excess is less than 130 µmol/goc, the sediments are presumed to "not likely" be toxic.

3.4 Vertebrate Wildlife Community Risk Analysis

Potential exposure routes for wildlife receptors include potential direct or indirect ingestion of surface water, sediment, and ingestion of food items containing COPCs. To evaluate potential wildlife exposure, representative wildlife species will be selected for evaluation in food chain models that estimate exposures to wildlife species respective to their position in the food chain. The following subsections present representative species, exposure parameters, COPC concentrations in prey items, calculation of potential doses, and evaluation of effects for vertebrate wildlife receptors.

3.4.1 Representative Species

As described in Section 5.4, the Waterside Investigation Area includes riverine aquatic habitat and wetland habitat. These areas may offer habitat resources for a variety of vertebrate wildlife species. However, due to the steep elevation change between the upland and the river, there is a general lack of wading habitat along most of the shoreline adjacent to the Site (i.e., the river becomes deep very quickly). Therefore, the evaluation of potential risks to wildlife will focus on the wetland area adjacent to the Site.

Since constituents may biomagnify through the food web, representative vertebrate wildlife species from multiple trophic levels will be evaluated. Carnivores and piscivores represent the top of the food chain and are potentially exposed to the higher levels of bioaccumulated analytes. Therefore, potential piscivorous wildlife receptors, great blue heron and raccoon, will be evaluated in food web models for the Waterside Investigation Area.

3.4.2 Estimation of Exposure

Wildlife species may potentially be exposed to COPCs in sediment and surface water through the incidental ingestion and food chain exposure pathways. Exposure assumptions (e.g., body weights, food and water ingestion rates, relative consumption of food items, foraging range, exposure duration, etc.) for the selected wildlife species, great blue heron and raccoon, will be obtained from the USEPA's Wildlife Exposure Factors Handbook (USEPA, 1993) and are provided in **Table 1**. Allometric equations (Nagy, 2001 and Calder and Braun, 1983) will be used to estimate food and water ingestion rates, respectively.

Food item concentrations will be modeled from measured concentrations in surface soil, sediment, and surface water. Calculation of food item concentrations is discussed below.

Wildlife exposure parameters and concentrations of COPC sediment, and surface water, and food items will be used to estimate the potential ingested doses to which wildlife receptors might be exposed at the site. Calculation of these ingested doses is discussed below.

3.4.3 Food Item Tissue Concentrations

Prey items for wildlife species (great blue heron and raccoon) evaluated in the food web exposure models will include freshwater fish, and if appropriate, represented by tissue concentrations from available studies (e.g., Pinkney et al., 2001; MDE, 2012). In the absence of site-specific tissue data, tissue concentrations may be estimated using literature-derived uptake factors. The primary source of uptake factors will be the uptake factors and regression equations recommended by USEPA in development of Eco-SSLs (USEPA, 2007b). In the absence of Eco-SSL-based values, other literature sources will be reviewed for relevant uptake factors.

3.4.4 Calculation of Potential Doses

To estimate potential dietary exposure, a total daily dose (TDD) will be estimated for each species. The TDD calculation considers the following factors: concentrations of the COPC in the food items that the species would consume, estimated amounts of abiotic media (e.g., sediment) that it would incidentally ingest, the relative amount of different food items in its diet, body weight, exposure duration (ED), species-specific area use factors (AUFs), and food ingestion rates. The ED represents the portion of the year that the receptor is exposed to the site (e.g., may be modified by migration). An AUF is defined as the ratio of the area of organisms' home range to the available habitat area within the site.

The following generalized equation will be used to evaluate the TDD from each source (i.e., food or prey item, drinking water, incidental ingestion):

$$\mathbf{TDD = \frac{(Tissue\ or\ Media\ Concentration \times Ingestion\ Rate \times ED \times AUF)}{Body\ Weight}}$$

This generalized equation will be modified for each representative species using the species-specific exposure parameters. The ERA will be conducted using conservative exposure and dose-response assumptions. The risk estimates may be further refined by using, for example: additional location-specific exposure data or location-specific bioavailability factors. Use of such refinements will allow the potential for risks to be put in perspective and will provide information that the risk manager may use to more accurately characterize risks on a location-specific basis and to communicate the nature of the risks.

3.4.5 Estimation of Effects

Toxicity reference values (TRVs) can be defined as the daily dose of a constituent that is considered protective of wildlife (mammals and birds) populations or individuals. The dose is expressed in milligram per kilogram body weight per day (mg/kg$_{bw}$/day) and can be based on either a NOAEL or a LOAEL.

TRVs incorporated into the quantitative evaluation of potential ecological risks to wildlife will be obtained primarily from two sources: the current USEPA Ecological Soil Screening Level (Eco-SSL) documents (available at www.epa.gov/ecotox/ecossl/) and Oak Ridge National Laboratory's (ORNL) publication *Toxicological Benchmarks for Wildlife: 1996 Revision* (Sample et al., 1996). When TRVs are not available in these documents, the literature will be reviewed for relevant data and TRVs derived using the methodology of ORNL (Sample et al., 1996).

USEPA guidance (USEPA, 1997) specifies that it is preferred that TRVs represent a NOAEL for chronic exposure to site-related constituents. Should a NOAEL not be available, USEPA guidance allows the use of the lowest exposure level shown to produce adverse effects (i.e., the LOAEL) in the development of TRVs. Both upper and lower bound TRVs (LOAEL-based TRVs and NOAEL-based TRVs, respectively) will be developed for this assessment in order to estimate a range of potential risks to mammalian and avian receptors. The NOAEL-based TRVs represent non-hazardous exposure levels for the wildlife species evaluated, while the LOAEL-based TRVs represent potential exposure levels at which adverse effects may become evident.

NOAEL-based TRVs will preferably be based on chronic NOAELs, with an emphasis on studies that measured effects on survival, reproduction, and growth endpoints applicable to the protection of wildlife populations. The following steps will be followed to select LOAEL-based TRVs:

- If a LOAEL is reported for the study used to derive the NOAEL-based TRV, that LOAEL value will be selected as the LOAEL-based TRV;
- In the case where the geometric mean of several NOAELs for growth and reproductive endpoints was used as the NOAEL-based TRV (i.e., EcoSSL-based TRVs), the geometric mean of the LOAELs for growth and reproduction will be calculated and selected as the LOAEL-based TRV;
- For EcoSSL-based TRVs, when the NOAEL-based TRV was based on a single NOAEL and no corresponding LOAEL is available, the upper-bound LOAEL for growth and reproduction will be used; and

- For TRVs derived from other sources, when there was no paired LOAEL, a factor of 4 will be applied to the NOAEL-based TRV to estimate a LOAEL-based TRV.

If no toxicity information is available for a COPC, and it is not possible to identify TRVs, potential risks associated with the estimated exposure for the respective COPC will not be quantitatively evaluated and the absence of toxicity information will be discussed as part of the uncertainty evaluation.

4 Risk Characterization

The results of the environmental risk analysis will be analyzed and interpreted to determine the likelihood of adverse environmental effects, and to determine whether a conclusion of no significant risk can be reached for each assessment endpoint evaluated. The ecological risk characterization will summarize the results of the risk analysis phase of work and will provide interpretation of the ecologically significant findings. Aspects of ecological significance that will be considered to help place the sites into a broader ecological context include the nature and magnitude of effects, the spatial and temporal patterns of effects, results of the background/reference site analyses, and the potential for recovery once a stressor has been removed.

Background data will be collected for many of the endpoints, including sediment and surface water concentrations. These background concentrations of COPCs provide valuable insight into what toxic chemicals may be entering the Anacostia River from other sources and will be considered in the risk analysis. In addition, the background data that will be collected as described in the RI/FS Work Plan, background or reference condition data from other ongoing projects on the Anacostia River may be considered (e.g., Kenilworth Landfill, Poplar Point, and Washington Navy Yard Remedial Investigation Reports will be reviewed and as appropriate, background data from these reports will be considered in the Benning Road RI).

The documentation of the risk characterization will include a summary of assumptions, uncertainties (both generic and site-specific), strengths and weaknesses of the analysis phase of work, and justification of conclusions regarding the ecological significance of the estimated (i.e., risk of harm) or actual (i.e., evidence of harm) risks.

The estimation of ecological risks involves a number of assumptions. A primary component of any risk assessment is an estimate or discussion of the uncertainty associated with these assumptions. The ERA for the Site will include examination of uncertainty related to the site-specific risk evaluations, and an analysis of the uncertainties which potentially affect all sites.

All discussions of uncertainty will include examination and review of several aspects of the ERA including, but not limited to, sampling, data quality, study design, selection of indicator species, estimates of exposure, and selection of ecological benchmarks and screening values. The uncertainty section of the ERA will identify limitations and assumptions and relate them to the potential effects these uncertainties may have on the overall conclusions of the ERA.

The major sources of uncertainty in a risk assessment include the potential for errors in assumptions, analyses, and in making measurements. Another source of uncertainty lies in the variability inherent in the components of the ecosystem being evaluated.

Although it is not practical to account for all sources of uncertainty, it is important to identify and address the major elements of uncertainty in the risk evaluation and assessment. Some uncertainties bias the results of the risk assessment towards excessive risk, while others bias towards no significant risk. Once identified, the uncertainties will be classified by this bias, and the overall effects on the risk assessment will be reflected in the conclusions.

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Table 1. Exposure Parameters for Wildlife Receptors

Receptor Species	Body Weight (kg)	Assumed Diet Fraction of diet as %; Amount as kg_{ww}/day Units	 Fish	Food Ingestion Rate (kg_{dw}/day)	Food Ingestion Rate (kg_{ww}/day)	Fraction Sediment in Diet (%) Amount as kg_{dw}/day	Water Intake Rate (kg/day)	Home Range (ha)	Exposure Duration (unitless)
Piscivores									
Great Blue Heron (*Ardea herodias*)	2.336 (a)	% kg_{ww}/day	95% 0.5521 (b)	0.1453 (c)	0.5521 (d)	5% 0.0073 (e)	0.1042 (f)	4.5 (g)	0.67 (h)
Omnivores									
Raccoon (*Procyon lotor*)	5.7 (a)	% kg_{ww}/day	91% 0.5510 (b)	0.1520 (c)	0.5510 (d)	9.4% 0.0143 (e)	0.4742 (f)	156 (g)	1 (h)

General Notes:

Food ingestion rates are wet weight for food items and dry weight for sediment/soil ingestion. As needed, rate may be converted.
Ingested diet and ingested abiotic media (i.e., soil or sediment) total 100% of dietary ingestion.
See individual organism notes for source, units, and conversion.
Moisture content of food items assumed to be as follows: 75% for Fish (USEPA, 1993).

BW - Body Weight.
COPC - Constituent of Potential Concern.
dw - Dry Weight.
FIR - Food Ingestion Rate.
ha - hectare.
USEPA - United States Environmental Protection Agency.
WIR - Water Ingestion Rate (1 L of water has weight of 1 kg).
ww - Wet Weight.

Footnotes for individual species parameters and assumptions presented on next pages.

Notes for Great Blue Heron (*Ardea herodias*):

(a) Average body weight of adult male and female herons (USEPA, 1993).
(b) Diet assumed to be exclusively fish.
(c) Food ingestion rate calculated using algorithm for carnivorous birds developed by Nagy, 2001 [FIR (g_{dw}/day) = $0.849*BW^{0.663}$].
(d) Dry weight food ingestion rate converted to wet weight food ingestion rate:

$$FIR_{ww} = \text{Sum } \{[(\text{Proportion of food}_i \text{ in diet}) \times (FIR_{dw})] / (1 - \text{moisture content}_i)\}$$

(e) Assumption for wading bird based on best professional judgement.
(f) Water ingestion rate calculated using algorithm for all birds developed by Calder and Braun, 1983 [WIR (kg/day) = $0.059*BW^{0.67}$].
(g) Average feeding territory size based on studies conducted in freshwater marsh and estuary in Oregon (USEPA, 1993).
(h) Great blue heron assumed to be migratory and present for 8 months of the year (March to October; USEPA, 1993).

Table 1. Exposure Parameters for Wildlife Receptors

Notes for Raccoon (*Procyon lotor*):

(a) Average body weight of adult male and female raccoons in Illinois, Missouri, and Alabama studies (USEPA, 1993).
(b) Diet assumed to be exclusively fish.
(c) Food ingestion rate calculated using algorithm for omnivorous mammals developed by Nagy, 2001 [FIR (g_{dw}/day) = $0.432*BW^{0.678}$].
(d) Dry weight food ingestion rate converted to wet weight food ingestion rate:

$$FIR_{ww} = \text{Sum } \{[(\text{Proportion of food}_i \text{ in diet}) \times (FIR_{dw})] / (1\text{-moisture content}_i)\}$$

(e) Value for raccoon soil consumption (Table 4-4; USEPA, 1993).
(f) Water ingestion rate calculated using algorithm for all mammals developed by Calder and Braun, 1983 [WIR (kg/day) = $0.099*BW^{0.90}$].
(g) Mean of home ranges from Michigan study (USEPA, 1993).
(h) Raccoon assumed to be present and actively foraging year-round.

Appendix G

Remedial Investigation Report Outline

Appendix G
Remedial Investigation Report Outline

Executive Summary

1. Introduction
- 1.1. Purpose of Report
- 1.2. Site Background
  - 1.2.1. Site Description
  - 1.2.2. Site History
  - 1.2.3. Previous Investigations
- 1.3. Report Organization

2. Study Area Investigation
- 2.1. Surface Features (topographic mapping, etc.) (natural and manmade features)
- 2.2. Contaminant Source Investigations
- 2.3. Surface Water and Sediment Investigations
- 2.4. Geological Investigations
- 2.5. Soil and Vadose Zone Investigations
- 2.6. Ground-Water Investigations
- 2.7. Ecological Investigations

3. Physical Characteristics of the Study Area
- 3.1. Surface Features
- 3.2. Meteorology
- 3.3. Surface-Water Hydrology
- 3.4. Geology
- 3.5. Soils
- 3.6. Hydrogeology
- 3.7. Demography and Land Use
- 3.8. Ecology

4. Nature and Extent of Contamination
- 4.1. Sources
- 4.2. Soil and Vadose Zone
- 4.3. Ground Water
- 4.4. Sediments
- 4.5. Surface Water

5. Contaminant Fate and Transport
- 5.1. Potential Routes of Migration (i.e., air, ground water, etc.)
- 5.2. Contaminant Fate
- 5.3. Contaminant Migration

6. Risk Assessment
- 6.1. Human Health Evaluation
  - 6.1.1. Exposure Assessment
  - 6.1.2. Toxicity Assessment
  - 6.1.3. Risk Characterization
- 6.2. Ecological

7. Summary and Conclusions
- 7.1. Summary
- 7.2. Conclusions

Appendices