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February 2016

REMEDIAL INVESTIGATION REPORT (DRAFT)

Benning Road Facility
3400 Benning Road, NE
Washington, DC 20019

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Executive Summary

This draft Remedial Investigation Report presents the results of recently completed environmental investigation activities at Pepco's Benning Road facility (the Site), located at 3400 Benning Road NE, Washington, DC. The Remedial Investigation and Feasibility Study (RI/FS) Study Area consists of a "Landside" component focused on the Site itself, and a "Waterside" component focused on the shoreline and sediments in the segment of the Anacostia River adjacent to and immediately downstream of the Site.

A significant number of sediment quality studies have been completed within the Anacostia River. The findings of these studies consistently show the presence of PCBs, PAHs, organochlorine pesticides, and metals in sediment samples collected from up and down the 8.4 mile-long stretch of Anacostia River in DC. For decades, there has been a broad recognition that the water quality and sediment quality in this urban 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. The Pepco Benning Road Facility was identified by DOEE as one of six sites along the lower Anacostia River suspected to be a significant source of contaminants in the river.

The RI/FS work has been conducted under the framework of a Consent Decree that 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 Anacostia River. The RI field activities were conducted in accordance with the RI/FS Work Plan and two Work Plan Addenda approved by the DOEE. The principal field activities were conducted between January 25, 2013 and December 31, 2014, and included sampling of landside soils, groundwater, storm drains, and Anacostia River sediment and surface water.

The purpose of the RI/FS 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 may be warranted. This draft RI Report addresses the first three objectives. The FS Report will address the development and evaluation of potential remedial actions.

The RI samples were analyzed for a broad suite of analytes, including metals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons

(TPH), pesticides, polychlorinated biphenyls (PCBs) and dioxins and furans. Project data quality objectives established in the Quality Assurance Project Plan (QAPP) were met, and over 99.9% of the laboratory results were deemed valid and usable for project decisions. The RI results are summarized below for the Landside and Waterside areas of investigation. The following discussion addresses the constituents of interest (COI) that were identified based on comparison of Study Area sampling data to conservative risk-based screening values.

Landside Investigation Area

A total of eighteen Target Areas (TAs) were investigated in the Landside Investigation Area. The major Landside findings are as follows:

- Many of the inorganics and all of the pesticides, VOCs, and SVOCs (except for a limited number of PAH compounds) that were detected in Site surface and subsurface soils were present at concentrations below their respective screening levels. The COI identified in Landside soils include a limited number of inorganics, PAHs, petroleum hydrocarbons in the aboveground storage tank (AST) area, PCBs, and dioxins and furans (surface soil only). Additional field investigation is necessary to understand Site contributions to the observed COIs.
- A limited number of metals, VOCs (primarily PCE and its daughter products), PAHs, pesticides, dioxins and furans, and PCBs were detected in groundwater above screening levels. PCE in the vicinity of DP-09 is not considered to be Site-related. However, the source of PCE concentrations observed in MW-01 and MW-02 in the southwest corner of the Site is not known, and an additional field investigation will further address these detections. The low levels of hydrophobic organics (i.e., PAHs, pesticides, PCBs, and dioxins and furans) observed are likely associated with turbidity in the groundwater samples. . In an upcoming additional field sampling phase, affected groundwater monitoring wells will be redeveloped and resampled to confirm the effect of sample turbidity on groundwater COI concentration levels.
- Several metals, PAHs, TPH, low levels of pesticides, and PCBs were detected in storm drain residue and water samples. In general, the PCB levels in the storm drain residue samples were significantly lower than levels detected during previous investigations.
- No non-aqueous phase liquids (NAPL) were observed in Site soils or groundwater.
- Preliminary forensic analysis suggests that PAHs in site soils are predominantly from combustion-related sources (pyrogenic) rather than fuels (petrogenic). This predominantly pyrogenic pattern is consistent with PAHs from urban background sources, such as vehicular exhaust and road runoff that have been reported in other urban rivers and waterways. Preliminary forensic analysis also indicated that the composition of PCBs detected at the Site differs from the composition of PCBs detected in Anacostia River sediments.

Additional follow-up forensic analyses will be needed to better define offsite versus onsite sources of PAHs and PCBs.

An additional investigation is necessary to delineate the COI exceedances observed in this investigation. The additional investigation is needed in multiple locations including, but not limited to the following:

- PCB impacts in soils around the cooling tower concrete basins (TA #5);
- Petroleum impacts from historical spills in the AST area (TA #13); and
- PCE in the vicinity of DP-09 is not considered to be Site-related. However, the source of PCE concentrations observed in MW-01 and MW-02 in the southwest corner of the Site is not known, and an additional field investigation will further address these detections.

The additional field investigation will be documented in an addendum to the RI/FS Work Plan that will be reviewed and approved by DOEE prior to its implementation.

Waterside Investigation Area

The Waterside Investigation Area focused on sediment and surface water adjacent to the Site, as well as ten background locations in the Anacostia River. The major Waterside findings are as follows:

- Several metals, pesticides, PAHs, PCBs, and dioxins and furans exceed ecological screening levels in sediment in the Waterside area of investigation. An evaluation of background conditions using Site-specific data indicates that the levels of most COI in surface sediment in the Study Area are consistent with Site-specific background conditions, although a few inorganics, PCBs, and dioxins and furans may be locally elevated relative to Site-specific background. The elevated levels of these constituents are generally located in the cove of the River into which Outfall 013 from the Site and three other discharge pipes not associated with the Site (referred to as non-Pepco outfalls) discharge.
- The levels of constituents in Study Area surface water are below ecological screening levels, with the exception of dissolved barium, two PAH compounds, and 4,4’-DDT. However, Study Area concentrations of these COI are consistent with Site-specific background.
- Based on an evaluation of fish tissue data collected by the District and the state of Maryland in support of consumption advisories, PCB levels in fish tissue are similar throughout the Anacostia River. Similar PCB levels were observed in species caught in the three reaches that were sampled, including the Lower Anacostia (from the confluence with the Potomac to the CSX railroad bridge), Upper Anacostia (from the CSX railroad bridge to the DC-Maryland state line, which includes the stretch adjacent to the Site), and the

upstream reach in Maryland. These findings suggest multiple sources of PCBs in the River, including upstream of the tidal influence of the Site.

Preliminary Baseline Risk Assessments

Based on the results of the preliminary baseline risk assessments, existing conditions within the Study Area pose limited risks to human and ecological receptors, and background conditions contribute significantly to such risks. The COIs were further evaluated in the preliminary Baseline Human Health Risk Assessment (BHHRA) and the preliminary Baseline Ecological Risk Assessment (BERA) to determine which COIs should be identified as Constituents of Potential Concern (COPCs). It should be noted that the preliminary baseline human health and ecological risk assessments were completed using the environmental characterization data generated through the investigation activities described in this RI Report. An additional field sampling event will be performed to address remaining Site data gaps and uncertainties. The preliminary baseline risk assessments will be revised following completion of the additional field investigation. As a result of this additional investigation, the list of COPCs will be reviewed and revised accordingly. The key findings of the preliminary baseline human health and ecological risk assessments are as follows:

- On a preliminary basis, the conditions in the Landside Investigation Area may not pose any unacceptable human health risks. To some extent, the existing operational and institutional controls that are in place at the Site provide effective exposure prevention measures, and direct contact exposure pathways may be currently incomplete or insignificant. However, at the request of DOEE, the potential for future direct contact exposure scenarios to surface and subsurface soils will be evaluated in a revised BHHRA to be completed pending collection of additional landside soil data and updates to the CSM. The scenarios to be included in the revised human health risk assessment will include current/future construction worker, future industrial worker, and future recreational user.
- With the exception of fish consumption, none of the Waterside exposure routes was determined to pose an unacceptable human health risk. Under the conservative assumptions used for the risk assessment, fish consumption poses a non-cancer risk above the USEPA target level due to PCBs, which is found at similar concentrations in fish tissue collected at sampling locations throughout the Anacostia River. This exceedance relates to non-cancer risk only. These findings indicate multiple sources of PCBs in the River, including upstream of the tidal influence of the Site.
- There is limited potential for risk to the benthic macroinvertebrate community, especially in the vicinity of the cove where Outfall 013 and three other outfalls discharge. However, the levels of most COPCs in surficial

sediment adjacent to the Site are consistent with site-specific background, and therefore potential risks cannot be solely attributed to the Site.

- There is limited potential for risk to the fish community based on PCBs levels observed in fish tissue.
- There is little to no potential for ecological risks to the wildlife community.

Based on the available data, the primary source of risk is PCBs in fish from the Anacostia River. The presence of elevated PCBs in fish tissue is a river-wide phenomenon that cannot be attributed solely to the Site.

RI Conclusions

The Pepco Benning Road facility RI activities completed to date have resulted in a preliminary characterization of potential impacts on Landside and Waterside portions of the Study Area. An additional field investigation phase will be necessary to sufficiently address the data gaps and uncertainties identified during the RI. Many of the constituents detected in the Study Area are consistent with background conditions, although this conclusion must be reassessed following additional field investigation to address data gaps. Within the Landside Investigation Area, several COPCs are elevated in subsurface soil and groundwater at discrete locations within the Site. Within the Waterside Investigation Area, concentrations of several COPCs are elevated in the cove of the River into which Outfall 013 and three other non-Pepco outfalls discharge. The preliminary human health and ecological risk assessments suggest that there may not be potential risks associated with exposure to environmental media at the Landside Investigation Area, and that potential benthic macroinvertebrate exposure to surficial sediments within the Study Area may be the sole potential exposure pathway warranting additional evaluation within the Waterside Study Area. However, following an additional phase of investigation, both the BHHRA and BERA will be revised using the additional data collected. The consumption of Anacostia River fish containing PCBs poses a potential risk to human health; however, fish throughout the river contain PCBs at similar concentrations, and thus potential human health risks cannot be solely or principally attributed to PCBs that originated from the Site.

Further Actions

Recommendations for interim actions on source areas identified during the RI activities conducted to date and for further data collection include but are not limited the following:

Interim Actions

Several interim actions have been completed, or are currently planned or under consideration at the Site.

- Excavation of PCB impacted soils from TA #5: Pepco has completed sampling to define the extent of PCB impacts and is in the process of obtaining DOEE's approval for a Removal Action Plan that will include excavation and off-site disposal of contaminated soil in this area.
- Petroleum Impacts in TA #13: If Pepco plans to reuse this area for purposes that require excavation or intrusive subsurface work, it is recommended that, pending the completion of a more comprehensive BHHRA, appropriate precautions be taken to reduce exposure to construction workers, and that any excavated soil be disposed of at an approved off-site disposal facility.
- Storm Drains, TA #17: The Site currently employs various BMPs to control sediments and contaminants in storm water discharged from the Site, including the use of filters, screens and absorbent booms at all storm drain inlets. However, a minor contribution from accumulated sediments already present within the storm drain system cannot be ruled out. To address this, Pepco has recently conducted a closed-circuit television (CCTV) inspection of the main 54-inch storm drain and identified several areas with accumulated sediments. Pepco subsequently completed a clean out of the entire storm drain system, and removed all accumulated sediments (approximately 47 cubic yards) for off-site disposal.
- Pepco will develop a formal Soil Management Plan that will govern appropriate health and safety precautions to be used by any site worker involved in disturbing surface or subsurface soils at the Benning Road facility.

Landside Investigation Area

- Additional sampling and investigation in accordance with the additional investigation Work Plan to be approved by DOEE is necessary to fully characterize the horizontal and vertical extent of impacts in the Study Area in order to understand the potential risks posed by the COPCs.
- Re-development and re-sampling of monitoring wells where hydrophobic organics were detected is needed.

Waterside Investigation Area

- It is recommended that additional Site-specific biological test data be collected to further evaluate the potential benthic macroinvertebrate ecological risk from exposure to the surficial sediments in the Waterside Investigation Area and to develop Site-specific action levels for consideration in the FS, if warranted.
- Final decisions regarding the need for sediment management actions at any location in the Study Area will be made following the additional field investigation. If it is determined that sediment management may be required in the cove where Outfall 013 and three other non-Pepco outfalls discharge or any other location in

the Study Area, pilot studies and treatability studies are warranted. These studies may include gridding the area to better understand the volumes and surface areas of sediment to be managed, sediment dewatering studies, sediment treatability studies focused on analysis of sequestration agents (the use of amendments to reduce bioavailability of contaminants by sorption or biodegradation of contaminants) and other active and inert capping materials, and geotechnical evaluations to better understand sediment and bulkhead stability.

Once the upcoming, additional field investigation phase is completed, the CSM is revised and expanded, additional background characterization work is completed, the Site characterization is updated, the BHHRA is expanded and revised, and the BERA is revised, Pepco will prepare a final version of this document for DOEE review and approval. Once the RI is approved, additional engineering design data may be collected and the remedy selection process for the Landside and Waterside Investigation Areas can proceed in accordance with DOEE requirements to determine the most appropriate mechanism(s) to address the limited potential risks within the Study Area.

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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
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
BTV	Background Threshold Value
BTAG	Biological Technical Assistance Group
CCTV	Closed-Circuit Television
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIP	Community Involvement Plan
CLP	Contract Laboratory Program
cm/yr	Centimeter per Year
COI	Constituent of Interest
COPC	Constituent of Potential Concern
CSF	Complete Sample Delivery Group File
CSM	Conceptual Site Model
CSO	Combined Sewer Overflow
CT	Cooling Tower
DC	District of Columbia
DCRA	Department of Consumer and Regulatory Affairs
DCWASA	District of Columbia Water and Sewer Authority
DOEE	Department of Energy and Environment
DGPS	Differential GPS
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DOD	Department of Defense
DPT	Direct Push Technolgy
DRO	Diesel Range Organics
EDD	Electronic Data Deliverables
EDR	Environmental Data Resources
EML	Estimated Minimum Level
EPA	Environmental Protection Agency
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ERI	Electrical Resistivity Imaging
ESA	Environmental Site Assessment
ESTCP	Environmental Security Technology Certification Program
FOD	Frequency of Detection
FS	Feasibility Study
FSP	Field Sampling Plan
ft bgs	Feet Below Ground Surface
GC/ECD	Gas Chromatography with Electron Capture Detection

GC/MS	Gas Chromatography/Mass Spectrometry
GIS	Geographic Information System
GPR	Ground Penetrating Radar
GPS	Global Positioning System
GRO	Gasoline Range Organics
GSA	General Services Administration
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
HI	Hazard Index
HMW	High Molecular Weight
HRGC/HRMS	High Resolution Gas Chromatography/High Resolution Mass Spectrometry
HSA	Hollow Stem Auger
ICP	Inductively Coupled Plasma
ICPMS	Inductively Coupled Plasma-Mass Spectrometry
IDW	Investigation Derived Waste
IQR	Interquartile Range
KPN	Kenilworth Park North
KPS	Kenilworth Park South
LCS/LCSD	Laboratory Control Sample/ Laboratory Control Sample Duplicate
LNAPL	Light Non-Aqueous Phase Liquid
LWZ	Lower Water-Bearing Zone
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
MLLW	Mean Low Low Water
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MW	Megawatt
MWCG	Metropolitan Washington Council of Governments
NAD83	North American Datum of 1983
NAPL	Non-Aqueous Phase Liquid
NCDC	National Climatic Data Center
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NPS	National Park Service
NPDES	National Pollutant Discharge Elimination System
NRDA	Natural Resource Damage Assessment
NTU	Nephelometric Turbidity Units
NWP	Nationwide Permit
ORO	Oil Range Organics
OSWER	U.S. EPA Office of Solid Waste and Emergency Response
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PCA	Principal Component Analysis
PCE	Tetrachloroethylene
PCBs	Polychlorinated Biphenyls
Pepco	Potomac Electric Power Company
PES	Pepco Energy Services
pg/g	picograms per gram
PID	Photoionization Detector
POP	Project Operating Procedure
PPE	Personal Protective Equipment

ppm	Parts per Million
PRG	Preliminary Remediation Goal
PSL	Project Screening Level
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/ Quality Control
RAO	Remedial Action Objectives
RAS	Routine Analytical Services
RAP	Removal Action Plan
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasbility Study
RL	Reporting Limit
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
TA	Target Area
TEQ	Toxicity Equivalent
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TCE	Trichloroethylene
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TRV	Toxicity Reference Values
TSCA	Toxic Substances Control Act
µg/kg	Microgram per Kilogram
UCM	Unresolved Complex Mixture
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
UWZ	Upper Water-Bearing Zone
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 draft Remedial Investigation (RI) Report on behalf of Potomac Electric Power Company (Pepco) and Pepco Energy Services, Inc. (collectively “Pepco”) to describe the implementation and findings of the Remedial Investigation/Feasibility Study (RI/FS) field activities conducted 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 1-1**. Together, the Site and an adjacent segment of the River are referred to herein as the “Study Area”. Pepco 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 principal RI/FS field activities were conducted between January 25, 2013 and December 31, 2014. A schedule showing the dates of key RI/FS project milestones is provided as **Table 1-1**.

The purpose of the RI/FS 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 may be warranted. This draft RI Report addresses the first three objectives. The FS Report will address the development and evaluation of potential remedial actions.

As described later in this document, the RI/FS Study Area investigation consists of a “Landside” component focused on the Site itself, and a “Waterside” component focused on the shoreline and sediments in the segment of the River adjacent to and immediately downstream of the Site. The Landside and Waterside Investigation Areas are depicted on **Figure 1-2**.

The RI/FS was 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 Department of Energy and Environment (DOEE, formerly the District Department of the Environment [DDOE]) guidance documents. Pepco submitted the Draft RI/FS Work Plan to DOEE in July 2012 and revised it to address comments from DOEE and the public. DOEE provided final approval for the Work Plan in December 2012.

Two addenda to the RI/FS Work Plan were prepared to describe supplemental RI field investigation activities. Addenda #1 and #2 were approved by DOEE in March and July 2014, respectively. Addendum #1 outlined a targeted sampling event to delineate a tetrachloroethylene (PCE) plume in groundwater along the Site's southern boundary, and specified details of the proposed monitoring well locations, construction, and sampling (AECOM, 2014a). Addendum #2 described a sampling program for soils beneath and around the cooling tower concrete basins in the northwest portion of the Site to define the extent of polychlorinated biphenyls (PCBs) in soils, and to develop a subsequent soil removal action plan (AECOM, 2014b). The Cooling Tower Basin Soil Removal Action Plan was approved by DOEE in July 2015 (AECOM, 2015). Removal of the basins and adjacent PCB-impacted soils is currently underway and is scheduled to be completed in April 2016.

1.1 Report Purpose and Scope

The purpose of this draft RI Report is to describe the RI field data collection program, to present the findings of the RI, to determine the nature and extent of contamination, to determine contaminant fate and routes of transport, and to evaluate present and future risks to human health and the environment from contamination detected in the Study Area. This report encompasses all environmental investigation activities conducted within the Study Area (Landside and Waterside) as described in the approved RI/FS Work Plan and Addenda #1 and #2 (AECOM, 2012; AECOM, 2014a; AECOM, 2014b).

This report contains information which has been used to develop a preliminary Conceptual Site Model (CSM); this CSM will be updated in a separate stand-alone CSM Technical Memorandum, and will be further revised in conjunction with additional field investigations that are currently being scoped.

1.2 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). The Site is one of six properties along the River identified by EPA and DOEE that are suspected sources of contamination (**Figure 1-3**). 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 site is also the location of three substations serving Pepco's transmission and distribution system. The Site was also the location of the former Benning Road Power Plant, which was permanently shut down on June 1, 2012. Demolition and removal of the power plant building and related infrastructure commenced in 2014, and all demolition and site restoration activities were completed in May 2015.

There have been five documented 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 documented historical environmental investigations and response actions conducted on the Site by Pepco and the USEPA is presented in **Table 1-2**. Nonetheless, it is suspected that these releases, and possibly other historical operations or activities at the Site, may have contributed to contamination in the Site media. 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 the Site is currently properly managed and that any spills or leaks of hazardous substances are quickly addressed and, if necessary, properly remediated. However, historical practices used to address hazardous substance spills are unknown and undocumented, and thus associated legacy contamination issues may exist.

1.2.1 Site Description and History

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 1-2**. As of June 1, 2012, operations at the Benning Power Plant ceased as announced by Pepco Energy Services (PES), which has owned and operated the power plant since 2000. The power plant was located on the westernmost portion of the Site, where it occupied approximately 20 percent of the facility's 77 acres.

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 operated and subsequently retired several different generating units, reflecting advances in technology and operating on different types of fuel. Four oil-fired boilers and two steam turbine units operated at the power plant in the recent past. The steam turbines, installed in 1968 and 1972, together 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 operated an average of 10 to 15 days annually. The power plant buildings and structures were demolished and removed in late 2014 and early 2015 under the oversight of DOEE and in accordance with permits issued by the D.C. Department of Consumer and Regulatory Affairs (DCRA). Backfilling and site restoration activities are scheduled to be completed by mid-May 2015.

Structures associated with the power plant included the generating station, two cooling towers, four fuel oil aboveground storage tanks (ASTs) and storage buildings. The closing of the power plant eliminated the need for the ASTs and cooling towers. Therefore, the four ASTs (with capacities of 50,000; 618,000;

1,847,000; and 1,984,000 gallons) were demolished in early 2013, and the superstructures of the two cooling towers were demolished in early 2014. The removal of the cooling tower basins and adjacent PCB-impacted soils is scheduled to be completed in April 2016.

The Service Center occupies the largest part of the property, and accommodates approximately 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 stations 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 substation # 7 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. The staging area is used for processing used electrical equipment and associated materials brought to the Site for reconditioning, recycling and/or disposal. The center of the Site is occupied by buildings used for office space, fleet services maintenance, and storage of hazardous and non-hazardous waste and materials. Areas located outside of the buildings are used for storage of new equipment 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 double-walled 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, and a second 20,000-gallon double-walled tank, installed in 1991, holds diesel fuel. All three tanks have leak detection monitoring devices which test the tanks and underground piping for leaks on a monthly basis. These tanks are registered with DOEE and are operated in full compliance with the District’s UST regulations. The locations of these USTs are shown on **Figure 1-4**. Another 20,000-gallon cathodically protected epoxy-coated steel tank, installed in 1979 and used to store gasoline, was removed in August 2012. The DOEE UST Branch inspected the tank site after the removal took place. The soil and groundwater samples, which were collected following DOEE’s inspection, did not show any detectable levels of constituents of concern. Accordingly, DOEE 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 and under DOEE oversight. The tanks ranged in size from 250 gallons to 15,000 gallons. Sampling was conducted following the tank removals and UST closure reports were submitted to DOEE in each case. These former UST locations fall within one of the Target Areas identified in **Table 1-3** and **Figure 1-4**. Please refer to **Table 1-3** for further details regarding the USTs and **Figure 1-4** 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 by 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 beneath the cooling tower superstructures. The area is no longer used for either purpose and is now covered by gravel. Railroad tracks enter the Site from the east and run to the west. The tracks were formerly used to transport coal to the power plant and are no longer active.

1.2.1.1 Storm Water Management

Storm water collected in storm drain inlets at the facility is discharged to the River via Outfall 013 and Outfall 101 (**Figure 1-4**) under the facility's NPDES permit (DC0000094). The majority of this stormwater runoff from the facility is conveyed through a 48 inch concrete pipe which widens to 54 inch before it discharges to the River via Outfall 013. The Site employs various Best Management Practices (BMPs) to control sediments and contaminants in storm water discharged from the Site, including the use of filters, screens and absorbent booms at all storm drain inlets. 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 were decommissioned and the superstructures of these towers were demolished in 2014, as Pepco ceased the operations at Benning Road Power Plant effective June 1, 2012. Outfall 101 receives storm water runoff from inlets in the southwest corner of the property. A detailed facility drainage area map is included in **Appendix A**. Outfall 101 also received storm water collected in secondary containment basins for transformers associated with the power plant. The transformers and their containment areas have been demolished and removed as part of the power plant demolition, eliminating the secondary containment discharges to Outfall 101.

There are three additional non-Pepco outfalls located adjacent to Outfall 013 that discharge into the Anacostia River. These outfalls appear to drain properties adjacent to the Benning Road site or adjacent roadways (e.g., the DC Department of Public Works Solid Waste Transfer Station and the NPS Kenilworth Maintenance Yard). There is also a city storm sewer outfall located adjacent to and approximately 20 feet downstream of Outfall 101. Photographs showing Outfalls 013 and 101 and adjacent outfalls are provided as **Figures 1-5a** and **1-5b**.

1.3 Previous Investigations

1.3.1 Historical Onsite Removal Actions and Investigations

1.3.1.1 Former Pepco Studies

A summary of documented historical environmental investigations and response actions conducted on the Site by Pepco and the USEPA is presented in **Table 1-2**. 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 soils were used to construct a wetland in the vicinity of the water intake. Dredging and wetland construction activities extended from the Benning Road Bridge for approximately 900 feet north (Pepco, 1996; Pepco, 1997). Post-dredging wetland sediment samples were collected by Pepco in 1996, as summarized in Table 1-2.

1.3.1.2 EPA 1997 Study

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 the presence of chlorine-treated city drinking water, which leaked to the storm drain from the onsite fire suppression system. The residue samples collected from the storm drain system indicated PCB and metal concentrations that exceeded USEPA Sediment Quality Guidelines (SQGs).

1.3.1.3 EPA 2009 Study

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.

1.3.1.4 Current DOEE Remedial Investigation

DOEE is conducting a River-wide Remedial Investigation within the tidal portion of the Anacostia River, which includes the Benning RI/FS Waterside Investigation Area. The study area for the DOEE RI is approximately nine miles long, between the confluence of the Northwest and Northeast branches of the River at Bladensburg, MD and the confluence with the Potomac River in Washington, DC. The objective of the DOEE RI is to determine the nature and extent of contaminated environmental media (surface water, sediment, groundwater seepage, and biota) in the study area that has resulted from numerous known or suspected sources of contamination along the River. The final DOEE RI Work Plan was completed on January 29, 2014, and field sampling activities were completed in May 2015 (DOEE, 2014).

1.4 Potential Sources of Contamination in the Immediate Vicinity of the Site

Potential sources of contamination to the river in the immediate vicinity of the Site include the Kenilworth Landfill, the Langston Golf Course, the former DPW trash incinerator facility, and the NPS Kenilworth Maintenance Yard. 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 1-3**), 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 Service. 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 separate remedial investigations (RIs) at KPN and KPS in 2007 and 2008 respectively for NPS (NPS, 2007; NPS, 2008). Constituents of Potential Concern (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). In February 2013, NPS proposed a plan for the cleanup of Operating Unit 1 (OU1) at the Kenilworth Park Landfill, comprised of surface and subsurface soils, including waste material disposed of within the landfill, but not the groundwater, sediments or surface water.

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 report 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 report 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 (NPS, 2001).

Another potential source of contamination in the immediate vicinity of the Site is a former trash incinerator facility located to the north of the site within the D.C. Department of Public Works Solid Waste Transfer Station property. The incinerator reportedly operated from 1972 to 1994 and at a capacity of 250 tons/day. Ash from the incinerator was reportedly disposed of at the Lorton landfill. No documentation of any environmental studies or sampling was available.

NPS Kenilworth Maintenance Yard is located to the northwest of the Site on the eastern shore of the Anacostia River. A vehicle refueling island is visible at the Kenilworth Maintenance Yard. The site is also on a 2014 DOEE list of known facilities with active USTs in the District. No documentation of any environmental studies or sampling was available.

1.5 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. 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. Fritz and Weiss (2009) summarized six possible sources of sediment contamination in the river as listed below, 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 the Benning Road 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 constituents 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 B – Figure 2**). 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 Outfall 013.

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 B**. 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.

The data presented above suggests that USEPA 2009 SI Report data must be considered within the overall construct of the urbanized Anacostia River corridor. USEPA's 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). A figure depicting the CSO outfalls and drainage areas in the vicinity of the Study Area is provided in **Appendix C**. 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.

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 October to December 2014, approximately 68.2 million gallons (MG) of CSO overflow were released into the River. Approximately 81.5% (55.6 MG) was attributable to CSO 019 (the Northeast Boundary CSO), while an additional 6.5% (4.44 MG) were attributable to CSO 010 (the O Street Pumping Station).

AECOM incorporated the findings from various studies discussed above, and response actions conducted by Pepco into the development of the RI/FS Work Plan and CSM for the Study Area.

1.6 Report Organization

This draft RI Report is organized into the following eight sections:

- Section 1 – Introduction
- Section 2 – Study Area Investigation
- Section 3 – Physical Characteristics of the Study Area
- Section 4 – Nature and Extent of Contamination
- Section 5 – Contaminant Fate and Transport
- Section 6 – Baseline Risk Assessment

- Section 7 – Summary and Conclusions
- Section 8 – References

Figures, tables, and appendices are provided as stand-alone sections following **Section 8**.

2 Study Area Investigation

This section presents a summary of the field activities conducted to date within the Study Area. This section describes the means and methods of sample collection, and quantities and locations of samples collected in various environmental media. Sections 3.0 and 4.0 of this draft RI Report discuss the results of field activities. The principal field activities were conducted between January 25, 2013 and December 31, 2014 in accordance with the RI/FS Work Plan, Sampling and Analysis Plan (SAP) and Health and Safety Plan (HASP), approved by DOEE in December 2012. Representatives of DOEE Toxic Substances Division conducted several inspections during the course of the Landside and Waterside Investigations. A photolog of field tasks completed during the Landside and Waterside investigations is provided in **Appendix D**.

Additional investigation activities not specified in the RI/FS Work Plan were presented in Addenda #1 and #2 to the Work Plan, and approved by DOEE in March and July 2014, respectively. Addendum #1 revised the Phase III activities to include the delineation of a PCE plume in groundwater near DPT boring DP09, and specified details of the proposed monitoring well locations, construction, and sampling. Addendum #2 outlined a soil sampling program for PCBs beneath and adjacent to the cooling tower basins. The field investigation activities were designed to characterize conditions in soil, groundwater, surface water, and sediment; further refine the CSM; and collect data to support a baseline risk assessment. The RI/FS activities were divided into a Landside investigation, which investigated the Site, and a Waterside investigation, which investigated a near-Site portion of the Anacostia River and ten background River locations upstream and downstream from the Site.

The Landside investigation was divided into three phases, which were subdivided as follows:

Phase I

- Task 1: Utility Clearance
- Task 2: Surface Soil Sampling
- Task 3: Storm Drain Sampling
- Task 4: Electrical Resistivity Imaging (ERI)
- Task 5: Geotechnical Soil Borings

Phase II

- Task 1: DPT Subsurface Soil Sampling

Phase III

- Task 1: PCE Source Investigation
- Task 2: Monitoring Well Installation
- Task 3: Monitoring Well Gauging and Sampling
- Task 4: Tidal Influence Monitoring
- Task 5: Aquifer Testing
- Task 6: Cooling Tower Basins Soil Sampling

The Waterside investigation was divided into two phases, which were subdivided as follows:

Phase I

- Task 1: Bathymetric and Utility Surveys

Phase II

- Task 1: Surface Water Sampling
- Task 2: Surface Sediment Sampling
- Task 3: Subsurface Sediment Sampling

Several permits from regulatory and other government agencies were obtained prior to the RI/FS field activities. These permits are summarized in **Table 2-1**. The sample quantities and analytical methods for the Landside and Waterside data collection programs are provided in **Table 2-2**. Details of specific field activities are described in the following paragraphs.

2.1 Landside Investigation

2.1.1 Phase I, Task 1: Utility Clearance

Numerous overhead and underground utilities are present at the Site, including those associated with three active electrical substations, the former power plant building, high-voltage transmission and distribution lines, and the elevated and underground DC Metro Rail lines along the Site's southern boundary. Known or suspected utilities at the Site included electric, water supply, storm sewer, sanitary sewer, gas, and telecommunication lines, and Anacostia River water intake/discharge tunnels associated with the former power plant building.

A multi-step utility clearance process was conducted for each proposed boring location and included the following:

1. Obtain and review available utility drawings from Pepco and others;
2. Obtain clearance from Pepco by having a Pepco Underground technician locate and mark utilities in the vicinity of each proposed boring;
3. Retain a private utility locator to locate and mark all active or abandoned subsurface utilities in the vicinity of each boring;
4. Notify Miss Utility for the identification of all public utilities servicing the Site; and
5. Hand-clear each boring location by use of hand auger and vacuum excavation/air knife to a depth of 5 ft below grade.

AECOM retained private utility designation contractors Accumark, Inc. of Ashland, VA, and Enviroscan, Inc. of Lancaster, PA, to identify underground utility lines in the vicinity of proposed drilling locations. The utility investigations included the use of ground penetrating radar (GPR) and electromagnetic sweeps of all boring locations using detection equipment to identify and mark induced or naturally occurring electromagnetic fields present on conductive utilities.

2.1.2 Phase I, Task 2: Surface Soil Sampling

Surface soil samples were collected at 25 locations (SUS01 through SUS25) distributed across the Site. All samples except one were collected between February 4 and February 7, 2013; the surface soil sample at location SUS22 could not be collected until June 13, 2013, due to access issues. The locations of the surface soil samples are shown on **Figure 2-1**, and analytical methods are presented in **Table 2-2**. The samples were collected from within the top 12 inches of the subsurface after coring through existing pavement or ground cover. Each sample was field screened with a PID and XRF instrument. The results of the surface soil sampling guided the planning of the DPT subsurface investigation.

This task was performed in accordance with the relevant Project Operating Procedures (POPs) provided in Appendix A of the SAP, including those for hand augering, soil sampling, use of the XRF instrument, decontamination of field equipment, and the packing and shipping of the environmental samples.

AECOM retained surveying contractor Gahagan & Bryant Associates, Inc. (GBA) of Wilmington, DE, to provide land surveying services for the RI/FS project. Location coordinates were referenced to the Maryland State Plane North American Datum of 1983 (NAD83) coordinate system, and elevations were recorded relative to the North American Vertical Datum of 1988 (NAVD88). Surveyed coordinates for the 25 surface soil sample locations are provided in **Table 2-3**.

2.1.3 Phase I, Task 3: Storm Drain Sampling

Eight storm drain water (SDW) and four storm drain residue (SDR) samples were collected on October 7 and 8, 2013, to determine potential impacts of stormwater runoff to the Site's storm drain system, which drains to the River at Outfalls 013 and 101. The locations of the storm drain samples are shown on **Figure 2-2**, and analytical methods for the samples are presented in **Table 2-2**. Location coordinates for the sampled storm drains, accurate to within 3 ft,, were collected by AECOM using a hand-held Trimble^{TM} GPS unit and are provided in **Table 2-4**. Six of the sampling locations were single storm drains from the main drainage system that traverses the Site from southeast to northwest and discharges to the River at Outfall 013, including five of the six locations (labeled PEPR 1 through 5) sampled during the 1997 USEPA Multi-media Inspection. Three of these six storm drains (PEPR1, PEPR2, and PEPR3) could not be sampled for residue due to lack of sufficient sediment in the drains. Alternative storm drains were not identified to be sampled because none were in close proximity to the proposed locations, and would not coincide with the 1997 USEPA Multi-Media Inspection sampling locations.

The other two sampling locations were storm drains to the west of the former power plant building that drain to Outfall 101. One sample (SDW101), collected by Pepco's stormwater management contractor, AMEC, according to a sampling protocol approved by USEPA for NPDES quarterly sampling, was a weighted composite of water from four of the eight storm drains in this area (manholes 87, 88, 90, and 91). The remaining four other storm drains on the west side of the plant were physically covered during the sampling event and excluded from the composite sample because their catchment areas were within those of the other storm drains sampled. The weightings for sample SDW101, based on the stormwater volumes flowing through each location, were as follows:

Sample Location	Catchment Area (ft^2)	Fraction of Sample Volume	Representative Sample Volume (mL)
MH-91	6,204	7.74%	1393
MH-90	3,853	4.81%	865
MH-88	26,149	32.61%	5,870
MH-87	43,975	54.84%	9,872

The other stormwater sample collected from west of the plant (SDWMH02) was a grab sample from manhole 88. A storm drain residue sample (SDR101) was also collected from this storm drain.

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

AECOM retained Aestus, LLC (Aestus) of Loveland, CO, to perform Electrical Resistivity Imaging (ERI) surveys at the Site between February 11 and February 16, 2013. ERI techniques involve the measurement of electrical conductivity/resistivity of the ground and are commonly used in environmental site characterization as screening tools. ERI data can be used to identify subsurface anomalies that represent changes in lithology, buried objects, and LNAPL/DNAPL plumes.

Aestus performed a total of ten ERI surveys (WAS-1 through WAS-10) at the Site using its proprietary GeoTrax Survey^{TM} technology. The locations of the ten transects, which are shown on **Figure 2-1**, were selected to image the former sludge dewatering area and other Target Areas. For each of the geophysical surveys, a series of electrodes spaced 5 to 10 ft apart were hammered into the ground to a depth of 6 to 15 inches bgs, and DC current was induced in the subsurface material along the length of the transect. The current measured by the electrical transducers was used to produce images of the conductivity/resistivity of the subsurface material. Survey line lengths ranged from 361 to 541 ft long, producing images showing differences in conductivity/resistivity of the lithology along the survey transects from 72 to 108 ft deep.

A technical memorandum for the ERI surveys prepared by Aestus is provided in **Appendix E**.

2.1.5 Phase I, Task 5: Geotechnical Soil Borings

A geotechnical investigation was conducted at the Site between March 14 and March 27, 2013, to aid in the verification of existing lithologic data and the design of monitoring wells. Five soil borings (SB1 through SB5) were installed at the locations shown on **Figure 2-1**. Coordinates for the boring are provided in **Table 2-4**. During DOEE's review of the RI/FS Work Plan, DOEE had proposed to install a sixth soil boring (SB6) on National Parks Service (NPS) property to the west of the Site, but after a prolonged effort on the part of AECOM and Pepco to obtain the requisite permit from NPS was unsuccessful, DOEE agreed to forgo this boring in December 2014. In February 2015, after the conclusion of RI/FS field activities, NPS granted Pepco the Special Use Permit for the installation of boring SB6 on NPS property. Given that SB6 was proposed as a geotechnical boring only and no chemical data were to be collected, Pepco proposed to defer the completion of SB6 to after submission of this draft RI Report, at which point DOEE would determine whether the boring was still required.

AECOM retained drilling contractor Eichelbergers, Inc. of Mechanicsburg, PA, to advance the five geotechnical borings at least 10 ft into the Arundel Clay confining layer that underlies the Site using a Hollow Stem Auger (HSA) drill rig. Total boring depths ranged from 60 to 99 ft bgs. Split-spoon samples were obtained using the Standard Penetration Test (SPT) in accordance with the American Society for Testing and Materials (ASTM) Standard D1586. Split spoon samples were collected continuously from the surface to the water table and then every five feet thereafter to the boring terminal depth. Soils were logged in accordance with the Unified Soil Classification System (USCS), and the number of blow counts (hammer strikes) required to advance the sampler 24 inches were recorded. Geologic logs for the geotechnical borings are provided in **Appendix F**. Soil cores were field screened for VOCs using a PID. The relevant POPs in Appendix A of the SAP dictated the procedures used for soil sampling, headspace analysis of VOCs in unsaturated soil samples, sample packaging and shipping, field equipment decontamination, and IDW management.

Shelby tube or disturbed samples (from drill cuttings) were collected from each boring in accordance with ASTM Standard D1587 and analyzed for ASTM Permeability, grain size, and Atterberg limits. A total of 33 geotechnical samples were collected and submitted to Craig Testing Laboratories of Maryland, Inc., of Beltsville, MD, and GeoTesting Express, Inc., of Acton, MA, for analysis. All boring locations were abandoned with grout using a tremie pipe and restored to match the existing surface cover.

2.1.6 Phase II, Task 1: DPT Subsurface Investigation

Following the initial field data collection activities of Phase I, Direct Push Technology (DPT) borings were installed across the site between March 29 and June 13, 2013, to evaluate the Target Investigation Areas, anomalies identified during the ERI surveys, and other areas of the Site. The purpose of the DPT subsurface investigation was to investigate potential sources of contamination, log lithologic data, and collect soil and groundwater samples to characterize the Site.

AECOM retained Green Services, Inc. of Bel Air, MD to install the soil borings using a Geoprobe® DPT drill rig. Forty-seven DPT borings (DP01 through DP47) were installed across the Site and advanced as deep as 62.5 ft below grade. The DPT borings were typically advanced to approximately five feet below the water table or refusal, whichever came first, except in locations where deeper borings were installed to investigate anomalies identified during the ERI surveys. The locations of the DPT borings are shown on **Figure 2-1**, and their surveyed coordinates are provided in **Table 2-4**.

A total of 142 soil samples and 48 groundwater samples were collected during the DPT investigation. Geologic logs for the DPT borings are provided in **Appendix F**, and sample analytical methods are presented in **Table 2-2**. Soil samples were collected from three depths in each boring and subjected to screening using a PID and an XRF field instrument. The sample intervals were generally at the 5, 10, and 15 ft bgs horizons, except where ERI anomalies were being targeted for sampling. Groundwater samples were collected from within the top five feet of the water table using a DPT screen point sampler or temporary monitoring well. Groundwater samples were collected over 5-ft intervals via temporary wells, except for DP34, DP35, and DP45, which were sampled by screen point sampler over shorter intervals to target anomalies identified during the ERI investigation. The procedures used for collecting groundwater samples from the boreholes are presented in Project Operating Procedure 406: Groundwater Sampling via Temporary Wells (Appendix F2).

Groundwater and soil samples were packaged on ice and shipped under chain-of-custody to TestAmerica Laboratories, Inc. of Pittsburgh, PA, for chemical analysis. The relevant POPs in Appendix A of the SAP dictated the procedures used for soil sampling, use of the XRF instrument, headspace analysis of VOCs in unsaturated soil samples, sample packaging and shipping, sealed-screen groundwater profiling, field equipment decontamination, and IDW management. Upon completion, the boring locations were abandoned with grout using a tremie pipe and restored to match the existing surface cover.

2.1.7 Phase III, Task 1: PCE Source Investigation

During the Phase II investigation, tetrachloroethylene (PCE) was detected in groundwater at a concentration of 160 parts per billion in the 25 to 30 ft bgs interval of DPT boring DP09, near the southern property boundary. In Addendum #1 to the RI/FS Work Plan, a groundwater investigation was proposed to further delineate the PCE plume, help identify a possible PCE source and determine the appropriate location for a groundwater monitoring well.

Twenty-three PCE Source Area Investigation borings were installed between April 14 and April 18, 2014, at the locations shown on **Figure 2-3**. Geographic coordinates for the boring locations (provided in **Table 2-4**) were obtained by AECOM using a hand-held Trimble^{TM} GPS unit. An iterative DPT sampling approach was implemented in which eight initial groundwater samples were collected from grid points surrounding DP09 and analyzed for PCE and its degradation products using an onsite mobile lab. Subsequent sample locations were then selected depending on the previous sample results until the outermost ring of borings around DP09 exhibited PCE concentrations down to a level of 30-50 ppb.

AECOM retained GSI Mid-Atlantic, Inc. of Bel Air, MD (GSI, formerly Green Services, Inc.) to provide drilling (DPT) and groundwater sample collection (screen point sampler) services, and New Age/Landmark, Inc., of Benton Harbor, MI, to provide mobile lab analysis services. Geologic logs (provided in **Appendix F**) were prepared for five of the boring locations to characterize the subsurface and confirm the presence of an upper silt-clay semi-confining layer that underlies the Site and separates an upper water-bearing zone (UWZ) from a lower water-bearing zone (LWZ). A total of 23 grab groundwater samples were collected using a screen-point sampler and inertial pump from five-foot intervals between 20 and 35 ft bgs, within the UWZ. Three deeper groundwater samples were collected from between 45 and 55 ft bgs to characterize the LWZ at those locations.

During this task, the relevant POPs from Appendix A of the SAP were followed for sealed-screen groundwater profiling, sample packaging and shipping, field equipment decontamination, and IDW management.

2.1.8 Phase III, Task 2: Monitoring Well Installation

Based on the results of the Phase I and II investigations and the PCE delineation near DP09, a total of 30, 2-inch diameter PVC monitoring wells were installed as nested well pairs at the 15 locations across the site. Two monitoring wells were installed at each location, a shallow well in UWZ and a deep well in LWZ, respectively. The locations of the monitoring wells are shown on **Figure 2-1**, and surveyed coordinates for the wells are provided in **Table 2-4**. The wells are identified with their location (MW-1 through MW-15) and a letter (A for shallow, B for deep).

One nested well pair (MW-6) was installed by Cascade Drilling, L.P. of Marietta, OH, on May 2, 2014. It was then determined that due to presence of numerous utilities, a multi-step utility clearance program was needed to clear utilities prior to drilling other wells. Therefore, the remaining 14 well pairs were installed between September 22 and October 17, 2014, by Summit Drilling Co., Inc. of Bridgewater, NJ, once AECOM had completed the multi-step utility clearance work. The wells were installed by the Sonic drilling method to a maximum depth of 66 ft bgs. Sonic drilling uses a combination of drill bit rotation, high-frequency vibration, and down force to penetrate even very dense material using minimal drilling fluids. During well installation, 4-inch soil cores were logged continuously and screened with a PID to determine the placement of the well screens. Screened intervals ranged from 10 to 25 ft in length in the upper and lower water-bearing zones. Monitoring well details, including screened intervals and surveyed location and elevation coordinates, are provided in **Table 2-3**.

The monitoring wells were installed as nested wells, with two well risers in a single borehole at each location. First, 6-inch sonic casing on 10-ft intervals was advanced to the boring terminal depth, providing continuous 4-inch soil cores. The lithology was logged to determine the proper screen intervals for the wells; geologic logs are provided in **Appendix F**. After the placement of the upper and lower screened intervals was determined, an 8-inch sonic isolation casing was advanced, overriding the 6-inch casing, to the total depth of the shallow well. Then the two-inch deeper well was constructed through the 6-inch well casing, introducing sand pack in the 4-inch annulus around the well to 2 ft above the screened interval. The 6-inch temporary casing was retracted following deeper well construction to the bottom of the UWZ. Above the sand pack and at the level of the silt-clay semi-confining layer, a seal of hydrated bentonite chips was set to prevent intermixing between the upper and lower water-bearing zones.

Following the hydration and curing of the bentonite seal, the 6-inch casing was removed from the location entirely, leaving the 8-inch casing in place for the installation of the shallow well. The shallow well was installed with a clean sand pack in the 6-inch annulus to two feet above the screened interval, above which was placed a 2-foot seal of hydrated bentonite chips. The wells were finished with a bentonite-cement mixture to grade and a flush mount locking well cap and cover. A generalized construction schematic for the wells is provided as **Figure 2-4**.

Following installation, the wells were developed using a surge block and submersible pump. Well development was conducted until at least five well volumes were removed from each well in accordance with the Work Plan. The final turbidities of many of the wells remained high even after extensive pumping. Approximately 100 gal of purge water were withdrawn from each shallow well and 150 gal from each deep well.

During this task, the relevant POPs from Appendix A of the SAP were followed for monitoring well construction and installation, monitoring well development, field equipment decontamination, and IDW management.

2.1.9 Phase III, Task 3: Monitoring Well Sampling and Gauging

Thirty groundwater samples (one per well) were collected by use of HydraSleeve^{TM} passive grab samplers from the center of the well screens. Analytical methods for the samples are presented in **Table 2-2**. HydraSleeves are single use (disposable) samples devices designed to collect groundwater samples directly from a desired screened interval of a well without having to purge the well prior to sample collection. Physically, the HydraSleeve consists of a section of lay-flat polyethylene tubing, sealed at the bottom end, and with a check valve at the top end. After positioning the HyrdaSleeve at the bottom of the desired sampling interval, the sampler is activated by pulling it upwards at a rate of approximately 1 ft per second. When the sampler is full, the check valve closes, excluding any more water from entering. The HydraSleeve sampler is manufactured by GeoInsight of Las Cruces, NM. Additional details regarding the HydraSleeve sampler are provided in Addendum #1 (AECOM, 2014a).

The model of HydraSleeve used for the RI/FS groundwater sampling was 8-ft long and collected 4-liters of volume. Following a period of at least seven days of well stabilization following well installation, the HydraSleeves were deployed to the middle of the screened intervals. The HydraSleeves were allowed to compress and the wells were allowed to equilibrate for at least 24 hours before retrieval and sampling. During HydraSleeve retrieval, a portion of each groundwater sample was set aside to measure water quality parameters. Groundwater samples were packaged on ice and shipped under chain-of-custody to TestAmerica Laboratories of Pittsburgh, PA.

Two site-wide water level measurement events were conducted to characterize local groundwater flow conditions. AECOM retained GBA to install a tide board on the Anacostia River at the Benning Road bridge referenced to the Mean Lower Low Water (MLLW) vertical datum. Tide board observations were made at the beginning and end of each water level gauging round.

During this task, the relevant POPs from Appendix A of the SAP were followed for groundwater water level measurement in a monitoring well and field equipment decontamination, and POP-407 from Addendum #1 outlined the procedures used for groundwater sampling with a HydraSleeve (AECOM, 2014a).

2.1.10 Phase III, Task 4: Tidal Influence Monitoring

A tidal influence study was conducted at the Site over a period of 48 hours from November 10 to November 12, 2014, to help evaluate the tidal effect of the Anacostia River on the Site water table. Water level data from the shallow and deeps wells at six locations onsite (MW-1, MW-3, MW-6, MW-8, MW-11, and MW-13) were monitored at 5-minute increments during the study. These wells were selected to evaluate the tidal effects on wells in the western portion of the site (near the River) and also to determine how far east (away from the River) the tidal influence reaches. Twelve pressure transducers (Schlumberger Micro-Divers) were deployed in the selected wells, and an additional transducer was secured at the surface to record barometric pressure over the study period. The data were downloaded and processed, including making the necessary barometric pressure corrections, using Win-Situ® software.

The study involved the deployment of pressure transducers in the selected wells, which recorded groundwater levels in 5-minute increments. The continuous water level data were used to determine the tidal effect of the adjacent River on the Site water table.

The Benning Road Bridge tide board was visually monitored by AECOM over an eight-hour period on November 11, 2014, and the gage height was recorded at 15-minute increments. These stream stage data were used to establish a relationship between the tide board and a US Geological Survey (USGS) hydrometric gauging station (gauge number 01651750) located approximately 1.2 miles upstream from the Site. Over the eight-hour period, the stream stage at the tide board and that at the USGS gauging station differed by an average of 0.17 feet (±0.03 ft, one standard deviation). This elevation relationship was used to compare the stream stage of the River and the monitoring well water levels over the course of the 48-hour study period, and to help determine the effect of the River's tidal fluctuations on the Site water table.

2.1.11 Phase III, Task 5: Aquifer Testing

Aquifer testing was conducted in 16 wells at 8 locations (MW-1, MW-3, MW-6, MW-9, MW-10, MW-11, MW-13, and MW-15) to characterize the hydraulic properties of the shallow and deep aquifers. These wells were selected to get a good geographical distribution of data across the Site. The testing was completed by slug testing techniques, consisting of three rising-head and three falling-head tests in each well, to determine the hydraulic conductivity (K) of the unconsolidated material in the vicinity of each well. The water level data were recorded at 0.5-second intervals using a LevelTROLL 700 data logger. The tests proceeded until the water levels recovered to within 10% of the static pretest levels. Slug testing data were interpreted using the Bouwer and Rice (1976) solution for confined and unconfined aquifers on AQTESOLV^{TM} Version 4.5 aquifer test analysis software. The AQTESOLV software uses the recorded water level data and well details (such as borehole and riser diameters, screen length, and aquifer thickness) as inputs to calculate hydraulic conductivity for the geologic formation in the vicinity of the well.

2.1.12 Phase III, Task 6: Cooling Tower Basins Soil Sampling

Historic sampling of soils around the two cooling tower concrete basins in the northwest corner of the Site was conducted in 1995, 2012, and 2013. In Addendum #2 to the RI/FS Work Plan, a soil sampling program was proposed to delineate PCB contamination in soils beneath and adjacent to the basins based on the results of the previous sampling events, which indicated the presence of PCBs in surface soils adjacent to the basins. The two concrete basins (units 15 and 16) are each approximately 307 ft by 57 ft, and were constructed in 1969 or 1970, when PCBs were widely added to sealants, caulks and many industrial products. Caulking material in the basin expansion joints is believed to be the source of the PCBs detected in the adjacent soils.

The most recent rounds of soil sampling at the cooling tower concrete basins were conducted on August 14-September 5, 2014, and February 5 and March 11-12, 2015, to fill analytical data gaps and further delineate PCB contamination in basin soils. The sampling events targeted the vertical and horizontal expansion joints of each concrete basin. During the 2014-2015 sampling events, a total of 207 soil samples were collected from areas adjacent to and beneath the basins and analyzed for PCBs. The results of these sampling events guided the development of a draft Soil Removal Action Plan (RAP) (AECOM, 2014c).

Pepco submitted an initial draft of the Soil RAP to DOEE on December 1, 2014 and received comments back on December 22, 2014. Pepco addressed the DOEE comments, which included collecting additional analytical data to bound previously detected PCB contamination at the basins, and as of April 2015 is finalizing a revised Soil RAP for submittal to DOEE.

AECOM retained GSI to provide direct push drilling services, and E2CR, Inc. of Baltimore, MD, to provide vacuum excavation services to support the sampling events.

2.2 Waterside Investigation

2.2.1 Phase I, Task 1: Bathymetric and Utility Surveys

Prior to initiation of the Waterside investigation, AECOM retained GBA to conduct bathymetric and side scan sonar surveys in the Waterside Investigation Area and prepare a contour map of the river bottom in this area. Bathymetric data indicates river bottom elevation at selected points while side scan sonar data produces a continuous image of the river bottom to reveal large pieces of debris, potential utilities, or other anomalies. The side scan sonar imagery was limited by its resolution (approximately 1 foot) and by the shadowing effects cast by river bottom objects. The surveys were conducted on February 11-13, 2013, in accordance with the hydrographic surveying procedures provided in US Army Corps of Engineers (USACE) Survey Manual EM 1110-2-1003. A single GBA-owned vessel was mobilized for the surveys, launched from Bladensburg Marina in Bladensburg, MD. GBA used an Odom Echotrac CV100 fathometer to collect water depth along parallel survey lines. The survey lines were run at 50-foot intervals within the survey area, and four additional survey lines were run perpendicular to these lines, along the axis of river flow. Geographic positions for each surveyed point were logged using a Trimble™ GPS. Time was recorded continuously so that a tidal correction could be made during post-processing. GBA established tide gauges at outfall 013 and on a bridge pier of the Benning Road Bridge, surveyed to Mean Lower Low Water (MLLW).

As a result of utility clearance activities, including a historical records search and visual inspection of the river bank on both sides of the River, two electric cable crossings within the investigation area were identified within the Waterside Investigation Area. These cable crossings were located and surveyed by GBA during the side scan sonar survey, and each were given a 100 ft buffer zone within which no drilling occurred.

2.2.2 Phase II, Task 1: Surface Water Sampling

AECOM retained Aqua Survey, Inc. (ASI) of Flemington, NJ, to provide vessels and vessel-based sampling services in support of the Waterside sampling program. Two ASI-owned vessels were launched from Bladensburg Marina for the work: a sampling vessel and a support vessel. Prior to Waterside Investigation activities, notices to the public and other boaters regarding the nature and dates of the planned environmental study in the River were posted at the Bladensburg Marina and in public spaces along the River. Surface water samples were collected at 20 locations (ten near-Site and ten background) between September 23 and October 3, 2013. The sample locations for the near-site Waterside Investigation Area are shown on **Figure 2-5**, and background sampling locations are shown on **Figure 2-6**. Geographic coordinates for the sample locations were collected by GPS at the time of sampling, and are provided in **Table 2-5**. Details of the Waterside Investigation data collection program are provided in **Table 2-2**.

The surface water samples were collected from approximately one foot above the sediment-water interface using a peristaltic pump and tubing secured to a pole with one-foot lengths marked on it. Two measurements of water quality parameters were taken at each sampling location using a YSI 6920 Sonde: one near the water surface, and a second from within one foot of the sediment surface. The water quality parameters measured in the field included temperature, dissolved oxygen, pH, turbidity, and conductivity.

During this task, the relevant POPs from Appendix A of the SAP were followed for surface water sample collection, sample packaging and shipping, and IDW management.

2.2.3 Phase II, Task 2: Surface Sediment Sampling

Surface sediment sampling was conducted at 56 locations (46 near-site and ten background) between November 5, 2013, and January 31, 2014. These locations are shown on **Figures 2-5** and **2-6**. Geographic coordinates for the sample locations were collected by GPS at the time of sampling, and are provided in **Table 2-5**. ASI provided vessel-based support services, and Normandeau Associates, Inc. (Normandeau) of Bedford, NH, provided additional sampling support services for mudflat sampling using a portable Vibracore.

Surface sediment grab samples were collected from a depth of 0 to 6 inches below sediment surface using a Petite Ponar grab sampler. Surface samples were inspected and logged for physical characteristics, including sediment color, particle size, odor, presence of fill material or other man-made materials, presence of sheens or NAPL, presence of aquatic biota and other notable features. Samples were also screened for organic vapors using a PID.

To facilitate the processing of sediment samples on land, a staging area was constructed next to the River immediately south of Benning Road on Kingman Island (National Parks Service property). Permits obtained by AECOM for this and other activities related to the Waterside investigation are summarized in **Table 2-1**.

Turbidity monitoring was carried out in accordance with DOEE Water Quality Certification #DC-13-001 and the turbidity monitoring procedures agreed upon by DOEE and Pepco. There were no exceedances of the established background turbidity at any location during the sampling activities. The turbidity monitoring data are presented in **Appendix G**.

Sediment samples for VOCs, Simultaneously Extracted Metals (SEM), and acid volatile sulfide (AVS) were collected prior to sample homogenization. The remaining samples were homogenized in a mixing bowl and placed in the appropriate sample containers. Details of the Waterside Investigation data collection program are provided in **Table 2-2**.

During this task, the relevant POPs from Appendix A of the SAP were followed for sediment sampling, headspace analysis of VOCs in unsaturated soil samples, sample packaging and shipping, and IDW management.

2.2.4 Phase II, Task 3: Subsurface Sediment Samples/Vibracore Boring

A total of 208 subsurface sediment samples were collected at 56 locations (46 Site-adjacent and ten background) between November 5, 2013, and January 31, 2014, concurrently and co-located with surface sediment sampling. The locations of the subsurface sediment samples for near-site and background locations are shown on **Figures 2-5** and **2-6**, respectively. Geographic coordinates for the sample locations were collected by GPS at the time of sampling, and are provided in **Table 2-5**.

AECOM retained Aqua Survey, Inc. for vessel-based sampling and Normandeau to support the mudflat sediment sampling adjacent to the River. The subsurface sediment cores were collected by advancing a Vibracore sampler to a maximum depth of 10 ft below sediment surface, or to refusal, whichever was encountered first.

As with the surface sediment sampling, a program of turbidity monitoring was implemented in accordance with DOEE Water Quality Certification #DC-13-001 and the turbidity monitoring procedures agreed upon by DOEE and Pepco. There were no exceedances of the established background turbidity at any location during the sampling activities. The turbidity monitoring data are presented in **Appendix G**.

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

- The core sampler, equipped with a plastic liner, was driven and extracted at each of the designated sample locations;
- The core liner was extracted from the core barrel and split open;
- If the core recovery was less than 8 ft long, the location was re-cored up to three times, at which point the longest of the three cores was sampled;
- The sediment sample was screened with a PID and logged for physical characteristics as with the surface sediment samples; and
- Samples from up to four horizons within each core were collected (1-3 ft, 3-5 ft, 5-7 ft, and 7-9 ft).

208 discrete interval subsurface sediment samples were collected for laboratory analysis from the 46 sampling locations in the Waterside Investigation Area and the 10 background locations. Analytical methods for the samples are presented in **Table 2-2**.

During this task, the relevant POPs from Appendix A of the SAP were followed for sediment sampling, headspace analysis of VOCs in unsaturated soil samples, sample packaging and shipping, and IDW management.

2.3 Investigation-Derived Waste (IDW) Management

IDW generated during the Landside and Waterside investigations included 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

All IDW was containerized and staged on the Benning Road Facility site and sampled for RCRA waste characteristics and PCBs. These wastes were managed by Pepco as dictated by the waste characterization results and disposed of at approved off-site disposal facilities. Disposal quantities and destinations for IDW created during the RI/FS investigation are as follows:

- 15,221 pounds of solid waste were disposed of at Veolia ES Technical Solutions, LLC, 4301 Infirmary Road, West Carrollton, OH 45449.
- 29,280 pounds of solid waste were disposed of at Old Dominion Landfill, 2001 Charles City Road, Henrico, VA 23231.
- 7,515 gallons of liquid waste were disposed of at CIPF Industrial/Domestic Wastewater Facility, 16,232 Elliot Parkway, Williamsport, MD 21795.

Copies of the waste manifests for transportation and disposal of the RI/FS IDW are provided in **Appendix H**.

2.4 Ecological Investigation

On December 17, 2014, an AECOM ecologist and scientist visited the RI/FS Study Area to conduct an ecological site assessment using the USEPA's Ecological Assessment Checklist (USEPA, 1997b) as specified by USEPA Region 3 ecological risk assessment guidance (http://www.epa.gov/reg3hwmd/risk/eco/faqs/slera.htm). The completed checklist is provided in **Appendix I**.

The ecological assessment was based on the December 17, 2014, site visit and on observations of wildlife in the Study Area made by RI/FS field staff during RI/FS field activities. The assessment focused on evaluating the aquatic habitat within the Waterside Investigation Area.

2.5 Deviations from Work Plan

This section describes the deviations from the approved RI/FS Work Plan during the implementation of the RI/FS field activities. Deviations in sample numbers are noted in **Table 2-2** and other deviations are noted below. In a majority of cases, the deviations resulted in Pepco performing more work than the work plan required.

Landside Investigation

- Eight ERI survey transects were proposed in the work plan; ten were conducted. The proposed ERI survey transect through Target Areas 1 and 10 was divided into two surveys due to the obstruction posed by the presence of a transformer storage area between the two Target Areas. Two proposed transects—that pass through Target Areas 4 and 13, and that through Target Area 7—were too long to be imaged and therefore were divided into two transects each to obtain the required data. These field changes resulted in a total of ten transects.
- During the installation of geotechnical soil borings during the Landside Phase I, Task 5, multiple Shelby tube samples of the Arundel clay could not be collected as proposed. Multiple attempts were made at collecting these samples, but were hampered by Shelby tube samplers getting damaged and/or stuck in Arundel clay due to the stiffness of the clay.
- One geotechnical boring was proposed to be installed on National Parks Service (NPS) property between the Site and the River. The required Special Use Permit from NPS was not issued until February 5, 2015, after the completion of the RI/FS field activities. DOEE has agreed to defer this boring until after the agency's review of this draft RI Report and will notify Pepco if this boring is still required.
- A total of 40 DPT borings were proposed; however, 47 were installed. The additional seven borings were advanced to target to investigate subsurface anomalies identified during the ERI surveys, primarily in Target Areas 1 and 13.
- A dynamic approach with a mobile lab was proposed for soil samples collected during the Phase II Landside investigation; all Phase II samples were sent to a fixed lab. A mobile lab was not used during Phase II due to the following reasons:
    - Given the long history of the facility and presence of numerous utilities, a multi-step utility clearance program was needed to clear utilities prior to drilling. The multi-step process involved

  - calling One-Call Utility Service, having a private utility locator mark/clear utilities around a proposed boring, and having Pepco's utility/facility coordinators verify that there are no other undocumented utilities in the boring vicinity. This multi-step process due to safety concerns required a significant lead time and precluded the use of a more dynamic approach.
  - There was no indication of significant source areas during Phase I sampling and the ERI verification borings. Pepco was prepared to perform additional sampling depending on the results from Phase II sampling, as necessary.
  - The DCRA drilling permit limited the numbers and locations of soil borings. Additional borings would have required permit amendments/revisions. This process would take several weeks and would not be conducive to the planned dynamic approach.
  - There are limited options for mobile labs that could produce quality data and they have limited availability. Working out the field logistics within the confines of the Consent Order required work plan and permit approvals, which would have prolonged the field activities schedule significantly. A decision was made, therefore, to send all samples targeted to be analyzed using a mobile lab to a fixed lab to provide a higher quality data.

Pepco employed a mobile lab in conjunction with DPT sampling in Phase 3 for the PCE investigation. The PCE investigation required real-time tracking of the PCE source and availability of mobile labs for field analysis of volatiles such as PCE is more common.

Waterside Investigation

- Two sediment samples WSED1 and WSED2 were proposed to be collected within the constructed wetland area to the west of the Site. Due to accessibility restrictions posed by the presence of sheet piling around the constructed wetland, these two samples were collected in the River channel just outside the wetland area.
- Several sediment samples were offset from their proposed locations due to the presence of utilities, sand bars, poor core recoveries, or other restrictive conditions in the River.

3 Physical Characteristics of the Study Area

This section summarizes the physical characteristics of the Study Area as determined from the RI/FS field activities described in **Section 2.0**, and a review of recent and historic literature. An understanding of the physical characteristics is essential to explain potential contaminant transport pathways, receptor populations, and to inform subsequent screening and development of the alternatives in the FS. Chemical characteristics describing the nature and extent of contamination within the Study Area is the subject of Section 4.0.

3.1 Site Improvements

The 77-acre Site is principally used as the Benning Service Center, which supports the operations and maintenance activities for Pepco's electric power transmission and distribution system in the Washington, DC area. A Site Plan is provided as **Figure 1-2**. Site improvements consist of paved roadways, parking lots and materials storage areas; three electrical substations; high-tension electrical transmission and distribution wires; and several warehouses, small buildings, and trailers in use by Pepco and Pepco subcontractor personnel. The Site topography slopes generally towards west, and reaches topographic high point in the south-central area of the Site along Benning Road. Surface elevations range from about 11 ft NAVD88 near the River along the western Site perimeter to about 36 ft NAVD88 in the east of the Site and at the topographic high along the southern Site boundary. The site is approximately 70% impervious surface; a surface cover map of the Site is provided as **Figure 1-2a**.

The former Power Plant building in the western portion of the Site was demolished in late 2014 and early 2015, with only the concrete foundation left in place. The area is being backfilled to grade with clean backfill; backfilling activities are scheduled to be completed in May 2015. The cooling tower superstructures in the northwest portion of the Site were demolished in early 2014; only the two concrete basins remain in place, and are scheduled to be removed in mid-2015 following the approval by DOEE of a proposed Cooling Tower Basins Soil Removal Action Plan. Four aboveground storage tanks were formerly located at the Site (ASTs #1, #2, #3, and #4 capacities 61,800; 1,847,000; 1,984,000; and 50,000 gallons, respectively). Three of these ASTs (#1, #2, and #3) were in the central-western portion of the Site (Target Area 13) and one (#4) was near the northwest corner of the site (Target Area 3). All four ASTs were demolished and removed in early 2013.

The three active electrical substations (#7 and #41 and #45) are each surrounded by a chain-link fence. Substation #7 is located along Foote Street at the Site's northeastern perimeter and is approximately 4.5 acres in area. Substation #41 is located along Anacostia Avenue in the northern portion of the Site, to the east of the former cooling towers, and is approximately three acres in area. Substation # 45 is located west of and adjacent to the Site main entrance on Benning Road and is approximately one acre in area. There is no PCB equipment currently in use at these substations.

Building #56 in the southeast corner of the Site is used for the service and repair of transformer equipment. As a result of Pepco's longstanding program to remove PCB equipment in the course of system repairs and upgrades, there are no known PCB transformers in Pepco's electrical distribution system.

If any transformers without a manufacturer-certified non-PCB label are brought to the Site for service, they are assumed to contain PCBs until tested. Therefore, untested transformers are staged at the Transportation and Distribution (T&D) Holding Area, located outside of Building #56, which consists of an approximately 42 ft by 22 ft concrete pad surrounded by a one-foot concrete berm. All materials delivered to this area are tested for PCBs content. Recovered oil containing 50 ppm PCBs or greater is drummed and moved to a Toxic Substances Control Act (TSCA) approved storage facility in Building #65 in the western portion of the Site for storage pending off-site disposal at a PHI audited and approved disposal facility. Recovered oil containing < 49 ppm PCB is pumped to two 10,000 gallon holding tanks, designated for accumulating oil containing < 49 ppm PCBs in Building #57. These tanks are installed in concrete vaults, which act as secondary containment. This waste oil is removed as needed by tanker truck to an approved off-site disposal facility. The concrete vault containing the waste oil tanks and the tanker truck loading area are both marked with PCB M_L labels.

As shown in the storm sewer drainage map provided in **Appendix A**, there are two storm drain systems at the Site. The majority of the Site is drained by the main storm sewer system that traverses the Site from southeast to northwest and discharges to the River at Outfall 013. The west side of the former Power Plant building is drained by a smaller storm sewer system that discharges to the River at Outfall 101.

An Environmental Data Resources, Inc. (EDR) data package for the Study Area was obtained as part of a records search for the RI/FS. A relevant portion of the EDR package, including historic aerial photographs, is included in **Appendix J**. The aerial photographs show the development of the Site and the surrounding area between 1937 and 2011. A summary of the historical development of the Site based on the aerial photographs and historic literature is provided in **Table 3-1**.

Geomorphological changes to the Anacostia River over time can be observed in the historic aerial photographs. Between 1937 and 1947, an arm of the River formed an island to the north of the Site. By

1957 this side channel had filled in and the island became part of the east bank of the River, now the Kenilworth Park Landfill Site. All that remains of this previous arm of the River is the cove into which Outfall 013 and three adjacent non-Pepco outfalls discharge.

3.2 Meteorology

Washington, DC is in the humid subtropical climate zone. Meteorological data were obtained from the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) website for Ronald Reagan Washington National Airport, located approximately 5 miles southwest of the Site. The historic data (1871 to present) indicate that the Washington, DC metro area receives an average of about 40 inches of precipitation annually, and daily mean temperatures range from about 36°F in January to 80°F in July, with a mean annual temperature of 58°F.

Three years of hourly meteorology data (2012-2015) were analyzed for Ronald Reagan Washington National Airport's meteorology observation tower. Over the three years, the prevailing wind observed was from the South. Wind from due South and South-Southwest accounted for 24% (13% being due south) of all wind occurrences for the area. The second most prevalent wind came from the North-Northwest, accounting for 10% of the observations. The average wind speed was approximately 4 m/s with 46% of the wind speed observations being between 1 and 4 m/s. Lastly, 11% of the hourly observations were calm. Three-year and 30-year wind roses for the airport are provided in **Appendix K**.

3.3 Surface-Water Hydrology

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 L**. 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 (MWCG) 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 (MWCG, 2007).

The Anacostia River is subject to tidal influence. River surface elevations in the Study Area generally range from approximately -1.7 ft to 3.3 ft MLLW. The average variation in the river's stage over a tidal cycle is about 1 meter (3.3 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. Mid-channel depths in the Study Area during mid-tide conditions range from 10 to 18 ft. 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. Pepco conducted cooling water intake dredging adjacent to the Site in 1996, and the Maryland National Capital Parks and Planning Commission is known to conduct dredging of the River in the Bladensburg area.

A bathymetric map of the Waterside Investigation Area based on a hydrographic survey performed by GBA is provided as **Figure 3-1**. At mid-tide conditions, the navigational channel ranges in depth from about 5 to 17 ft. The deepest part of the channel is generally the outside of each bend, where flow velocity and erosional forces are greater. A sand bar is in evidence directly south of the Benning Road Bridge, likely due to greater sediment deposition in this area caused by the interruption in flow downstream of the bridge pier.

Mud flats are exposed at low tide along the eastern bank of the River on either side of the Benning Road Bridge and in the area of the cove into which Outfall 013 and three adjacent non-Pepco outfalls discharge. Two constructed wetlands surrounded by sheet piling exist along the eastern bank of the River in the Waterside Investigation Area: one directly west of the Site, and another approximately 325 ft south of the Benning Road Bridge. There is also a sea wall along the eastern bank of the River to the west of the Site, as shown in **Figure 1-4**.

Side scan sonar imagery for the Waterside Investigation Area is provided as **Figure 3-2**. The side scan sonar imagery shows several objects on the river bottom, including trees and tree stumps, wire fencing, shoreline sea walls, and the two previously identified cable crossings.

Geologic logs for the sediment sample locations are provided in **Appendix F**. Geologic logs for the River coring locations revealed the presence of primarily silt deposits in the sediment column from zero to ten feet below top of sediment. Silt was in many cases underlain by sandy sediments between five and ten feet below top of sediment. Trace organic material was ubiquitous within the surficial two feet, including leaves, twigs, and macroinvertebrates. Field soil descriptions agreed well with laboratory-provided geotechnical results.

3.4 Geology

3.4.1 Regional Geology

The facility is located within the Coastal Plain Physiographic Province, which is characterized by eastward thickening sequences of unconsolidated deposits. The western limit of the Coastal Plain Province is referred to as the Fall Line, where the metamorphic and igneous bedrock of the Piedmont Physiographic Province dips to the southeast beneath the younger sediments of the Coastal Plain (Johnston, 1964). 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 3-3**.

3.4.2 Site Specific Geology

Geologic logs for the borings and monitoring wells installed during the Landside and Waterside Investigations are provided in **Appendix F**. Landside boring locations are shown on Figure 2-1 and Waterside coring locations are shown on **Figure 2-5** (near-Site) and **Figure 2-6** (background). Laboratory reports for the geotechnical analyses are provided in **Appendix M**, and a summary of the geotechnical results is provided in **Table 3-1**.

The soils underlying the Site consist primarily of (from shallowest to deepest): artificial fill material; the Patapsco Formation; the Arundel Clay unit; and the Patuxent Formation. The Patuxent Formation overlies the crystalline bedrock. The RI/FS subsurface investigation principally targeted the artificial fill material and the Patapsco Formation at the Site, while confirming the depth of the Arundel Clay at several locations.

The artificial fill material at the Site primarily consists of infrastructure (utilities and structures), historical fill material used to level the Site, and relatively impermeable pavement (asphalt and concrete). Fill material thickness averages about 5 to 8 ft across much of the Site. Areas with thicker layers of fill material include the former sludge dewatering area, and areas where subterranean tunnels and storm drains exist. Fill material in the former sludge dewatering area to the south of the cooling towers is approximately 14 ft thick, fill material surrounding the intake and discharge tunnels to the west of the former power plant are approximately 20 ft deep, and fill associated with the underground Metro line underlying the southeast portion of the Site along Benning Road is approximately 25 to 30 ft deep. The main 54-inch storm drain that traverses the Site from southeast to northwest reaches up to 20 ft bgs where it exits to the north of the Site at Outfall 013.

The Patapsco Formation in the area of the Site consists of a highly variegated mixture of brown and gray clays, silts, and graded sands, with lenticular beds of coarse sands and minor gravels. The subsurface investigation identified a silt-clay semi-confining layer underlying much of the Site and dividing the Patapsco Formation aquifer into an upper water-bearing zone (UWZ) and lower water-bearing zone (LWZ). The top of the silt-clay layer was encountered between 25 and 40 ft bgs, and the layer averaged about 6 ft in thickness. An isopach map showing the approximate thickness of the silt-clay layer within the Patapsco Formation at the Site is presented in **Figure 3-8**.

Underlying the Patapsco Formation is the Arundel Clay, a distinct regional confining layer, comprised of very stiff, fat, mottled maroon and dark grey clay. The Arundel Clay underlies the Site at a depth of between 45 and 85 ft bgs, and generally dips toward the west. 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.

Geologic data from RI/FS and historical borings were used to create generalized geologic cross sections for the Site at the transects shown on **Figure 3-4**. Cross section A-A’ (**Figure 3-5**) runs in the north-south direction along the western Site perimeter, and shows a surficial fill layer, the silt-clay semi-confining layer that divides the UWZ and LWZ, and a deeper silt-clay deposit that overlies the Arundel Clay. This cross section also includes a USGS lithologic boring (DCHP01) that was completed in 2002 on the mud flat to the northwest of Outfall 013 (USGS, 2002). The geologic log for this boring, as well as a regional geologic profile produced by the USGS, is provided in **Appendix N**.

Cross section B-B’ (**Figure 3-6**) runs in the north-south direction through the middle of the Site, and was created from lithologic data collected during the RI/FS, as well as one historic geotechnical boring (GEO-B-7) that was installed by Geomatrix, Inc. in 1988. Similar to cross section A-A’, cross section B-B’ shows a surficial fill layer, the silt-clay semi-confining layer, and a deeper silt-clay deposit that overlies the Arundel Clay, as well as several silt or clay lenses within the Patapsco Formation. The water table generally follows the surface topography.

Cross section C-C’ (**Figure 3-7**) traverses the length of the Site from east to west, and includes RI/FS borings as well as historic geotechnical borings installed by Geomatrix, Inc. in 1988 (GEO-B-3 and GEO-B-36) and CTI Consultants, Inc. in 2009 (CTI-B-5 and CTI-B-3). Similar to the other two cross sections, cross section C-C’ shows a surficial fill layer, the silt-clay semi-confining layer, a deeper silt-clay deposit that overlies the Arundel Clay, and several silt or clay lenses. It should be noted that the three cross sections are generalized and do not show the numerous small (<1 foot thick) lenses of silt and clay that were encountered within the UWZ and LWZ of the Patapsco Formation.

3.5 Hydrogeology

3.5.1 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. A geotechnical analysis of Arundel Clay samples collected during the RI/FS indicated the Clay's hydraulic conductivity is on the order of 10^{-9} ft/sec. The Patuxent Aquifer, located beneath the Arundel Clay, flows under confined conditions towards the east (DC Water Resources, 1993).

3.5.2 Site Specific Hydrogeology

The water table aquifer (upper water-bearing zone, UWZ) generally ranges from 9 to 16 ft bgs, but reaches as deep as 26 ft bgs in the vicinity of the topographic high in the south-central portion of the Site. The piezometric surface of the lower water-bearing zone (LWZ) aquifer at the Site generally averages 0 to 2 ft deeper than the UWZ water table. A table of vertical hydraulic gradients at the 15 nested well locations during mid-tide conditions is provided as **Table 3-3**. All locations exhibit a downward vertical hydraulic gradient except for MW-1 and MW-6, which show slight upward vertical gradients.

Groundwater contour maps have been prepared for average (mid-tide) groundwater levels in the UWZ and LWZ are provided in **Figures 3-9** and **3-10**, respectively. Mid-tide groundwater levels were computed from gaging measurements collected during mid-tide conditions in the Anacostia River. Based on the results of the tidal study, there is little variation in water levels (1-3 inches) across much of the site (excluding the southwest corner near the dredged inlet [MW-01]) between low and high tides. The direction of groundwater flow in both aquifers is generally toward the River to the west. In both aquifers, groundwater flow in the northern and eastern portions of the Site is toward the northwest, while groundwater flow in the western and southern portions of the Site is toward the west or southwest. In both the UWZ and LWZ, horizontal hydraulic gradients become shallower nearer the River. During high tide conditions, hydraulic gradients in the southwestern portion of the Site may flatten completely or temporarily change directionality. Horizontal hydraulic gradients ranged from about 0.004 to 0.01 in the UWZ, and from about 0.005 to 0.008 in the LWZ.

The 48-hour tidal study conducted in six well pairs showed evidence of tidal influence across the Site in both upper and lower aquifers. The greatest influence by far was observed at MW-1 in the southwest corner of the Site, where groundwater levels in both the UWZ and LWZ varied by approximately 3 ft over a tidal cycle. MW-1 is directly adjacent to the inlet of the River that was dredged by Pepco in 1996 to provide cooling water to the Power Plant via intake/discharge tunnels. Groundwater levels across the rest of the site in both the UWZ and LWZ fluctuated by only 1 to 3 inches over a tidal cycle, and exhibited less variation with increasing distance from the River. The results of the tidal influence study indicate a hydraulic connection between the River and the UWZ and LWZ aquifers at the Site, but with the exception of the southwest corner of the Site the degree of tidal influence by the River on the Site water table is minimal. The results of the tidal study are provided in **Appendix O**.

The results of the aquifer testing conducted in eight well pairs distributed evenly across the Site indicate that hydraulic conductivities in the UWZ and LWZ range from approximately 10^{-6} to 10^{-5} m/sec, which is consistent with unconsolidated deposits of silty sands or fine sands (Freeze and Cherry, 1979; Fetter, 1988). The results of the aquifer testing are presented in **Table 3-4**, and summary reports for the aquifer tests generated by AQTESOLV™ are provided in **Appendix P**.

3.6 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.

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. Based on a review of the Environmental Data Resources, Inc. (EDR) Report dated January 2015, no water supply wells are located within 0.5-mile 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).

3.7 Ecology

The ecological findings are based on a December 17, 2014 site visit, field staff wildlife observations, and the completion of an Ecological Assessment Checklist (provided in **Appendix I**). Two patches of emergent wetland vegetation (approximately 2,000 and 10,000 square feet in area) are visible along the eastern shoreline of the Anacostia River at the southern end of the Waterside Investigation Area. Signage along the shoreline near these patches indicates that they are part of the Anacostia River Fringe Wetlands Restoration. The dominant vegetation of these patches is *Phragmites australis* and *Typha* sp. Both wetlands have sheet pile bulkhead surrounding the areas with some openings for surface water movement between the wetlands and the river. Evidence of flooding (e.g., watermarks on wetland vegetation and trees) is visible along the shoreline.

Most of the eastern shoreline is stabilized with either sheet pile or rockwall. Riparian vegetation consists of large trees and shrubs, which appears dense in some areas and sparse in other areas. Tree species include maple, oak, and sycamore. The bank slope ranges from gradual to shallow slope to the river edge. The western shoreline is uniformly stabilized with a continuous rock wall with dense tree cover throughout.

Outfall 013 discharges into an cove of the River approximately 2.3 acres in area, to the northwest of the Benning Road Facility, directly north of the NPS Kenilworth Maintenance Yard and west of the DPW Solid Waste Transfer Station. Mudflats are exposed in this area during low tide, and the shoreline of the cove is gradual in slope with little bank stabilization.

Several bird species were observed on the water and on mudflats in the river on December 17, 2014, including mallards (*Anas platyrhynchos*), gulls (*Laridae* family), Canada geese (*Branta canadensis*), and belted kingfisher (*Megaceryle alcyon*). In addition, wildlife observations were made during sediment sampling activities in November, 2014. The following bird species were observed in the vicinity of the Waterside Investigation Area:

- Canada geese

- Mallards
- Gulls
- Blue heron (*Ardea herodias*)
- Cormorants (*Phalacrocorax auritus*)
- Bald eagle (*Haliaeetus leucocephalus*) (upstream near National Arboretum)
- Bufflehead ducks (*Bucephala albeola*)
- Egret (*Ardea* sp.)
- Deer (*Cervidae* family)

The following aquatic organisms were noted in the Ponar grabs:

- Freshwater bivalves
- Freshwater eel (elver)

4 Nature and Extent of Contamination

The objective of this section is to describe the nature, and lateral and vertical extent of contamination detected in the Landside and Waterside portions of the Study Area such that informed decisions can be made regarding the level of potential human health and ecological risks presented by the Site. The laboratory and field data (described in Section 2.0) in conjunction with physical features of the Site (Section 3.0) are used to achieve this objective. All activities described in the approved RI-FS Work Plan were conducted during the RI field investigation, except where noted in **Section 2.5**. However, as presented in discussions in this section, the sampling results indicate several data gaps and uncertainties in Site impacts to Landside environmental media. Additional field activities to address these data gaps and uncertainties will be documented in Addendum #3 to the RI-FS Work Plan, to be prepared. This draft RI report will be finalized upon completion of the additional field investigation.

For purposes of focusing the discussion of the field sampling data, this section identifies the Constituents of Interest (COIs) in each environmental medium, namely Site soil, Site groundwater, Site storm drains (storm water and storm drain residue), Anacostia River surface water, and Anacostia River sediments, for the purpose of discussing the results. For each medium, the COIs are defined as those constituents detected at concentrations exceeding their respective screening levels. The COIs were further evaluated in the preliminary Baseline Human Health Risk Assessment (BHHRA) and the preliminary Baseline Ecological Risk Assessment (BERA) to determine which COIs should be identified as Constituents of Potential Concern (COPCs). The result of the COI determination are considered preliminary subject to revision. As noted above, an additional field sampling event will be performed to address remaining Site data gaps and uncertainties. As a result of this additional investigation, the list of COPCs will be reviewed and revised accordingly. The environmental transport and fate of the COPCs is described in Section 5.0 and BHHRA and BERA are presented in Section 6.0.

Data collected during the field investigation program (such as field data, laboratory data, and geospatial data) were uploaded to and stored in the project database. Laboratory deliverables were received in an AECOM-specified electronic format and were uploaded into a site-specific EQuIS database. Since the data are used as the basis for decision-making, the laboratory analysis of samples must meet specific QA/QC requirements laid out in the Quality Assurance Project Plan (QAPP). All laboratory data were first subjected to data validation to determine its usability in decision-making. Validated data are then tabulated to perform data analysis and evaluation.

This section begins with a discussion on data validation and assessment of quality assurance requirements. Data Validation Reports and Validation Qualified Results (with validation qualifiers) are provided in **Appendix Q** and **Appendix R**, respectively. A summary of Quality Assurance Assessment is provided in **Appendix S**. Full laboratory raw data packages are provided in **Appendix T**. As the Data Validation Reports, validation qualified results tables, and raw data reports are voluminous, they are provided in electronic form on Compact Disc under **Appendix Q, Appendix R** and **Appendix T**, respectively.

Following the discussion on validation, an evaluation of the sampling results is presented by environmental medium. Data summary tables for various environmental media along with calculated statistics for use in discussions in this section are provided as **Table 4-1** through **Table 4-11**. Field x-ray fluorescence (XRF) data correlation plots are provided in **Appendix U**.

Project Screening Levels (PSLs) were established in the SAP using very conservative, non-site-specific exposure assumptions. The purpose of these PSLs was to select appropriate analytical methods. As such, some PSLs may have been revised during the risk assessment process to ensure that the screening levels used to evaluate the RI field sampling results are the most current available and reflect Site-specific considerations where appropriate. The screening levels used in the evaluation of nature and extent are the same screening levels that were used in the human health and ecological risk assessments. In addition, groundwater quality standards from the District of Columbia Municipal Regulations (DCMR) Chapter 21, Section 1155.3 and DC UST cleanup standards for petroleum impacted soils were used as screening levels where appropriate. Screening levels and their sources are provided in Tables 4-1 to Tables 4-11.

Background and reference area information is integral to evaluating potential risks posed by environmental conditions at a site. USEPA defines background as: “Substances or locations that are not influenced by the releases from the Site and are usually described as naturally occurring or anthropogenic.” The Anacostia River has been impacted by a variety of historical and ongoing background sources of chemical, physical, and biological stressors from point and non-point sources, including NPDES discharges, surface runoff, combined sewer and storm sewer outfalls, refuse disposal practices, tributary inputs, and atmospheric deposition (SRC and NOAA, 2000). Due to the widespread presence of a variety of chemical contaminants in the Anacostia River watershed, the Site investigation results need to be evaluated in the context of regional background conditions. A preliminary background data evaluation conducted for the Study Area is provided as **Appendix V**. This preliminary background data evaluation is referenced in the “Nature and Extent” discussions as needed. Pepco is currently working on refining the background data evaluation. Pepco will document the refined background evaluation in a technical memorandum to be submitted to DOEE for review and approval.

The evaluation of sampling results is followed by a summary of the preliminary forensic analysis. This preliminary forensic analysis is intended to answer whether and to what extent past or current conditions at the Site have caused or contributed to contamination of the River. Supporting information for the preliminary forensic analysis is provided in **Appendix W** and **Appendix X**, and summarized in **Table 4-12** through **Table 4-20**. Finally, this section summarizes evaluation of contaminant sources based on sampling results evaluation, forensic analysis, knowledge of Site operations, and historical documentation. As noted above, an additional field investigation will be performed to address remaining Site data gaps and uncertainties, including uncertainties associated with the preliminary forensic analysis. As a result of this additional investigation, the preliminary forensic analysis will be reviewed and revised accordingly.

4.1 Data Validation Summary and Quality Assurance Assessment

4.1.1 Data Validation Summary

Data validation was performed on all Phase 1, Phase 2, and Phase 3 laboratory reports to assess data quality per Section 8.2.3 of the QAPP (AECOM, 2012). Each laboratory report was reviewed to determine compliance of the documentation and quality control results with criteria specified in the QAPP Table 1, the relevant EPA reference methods, and the guidance provided in EPA's National Functional Guidelines for Inorganic and Organic Data Review (USEPA,2010 and USEPA,2008, respectively). Modifications were made to accommodate non-Contract Laboratory Program (CLP) methodologies. Reviewed data elements are defined in the individual data validation reports for each laboratory report or group of laboratory reports and may include:

- Data completeness (chain-of-custody/sample integrity)
- Holding times and sample preservation
- Initial calibration/continuing calibration verification
- Laboratory blanks/equipment blanks
- Surrogate spike recoveries
- Matrix spike (MS) and/or matrix spike duplicate (MSD) results
- Laboratory control sample (LCS)/laboratory control sample duplicate (LCSD) results
- Field duplicates
- Sample results/reporting issues

Other method specific QC elements, such as mass spectrometer tuning, internal standard performance, interference check sample results, and labeled standard recovery, were also reviewed as needed. Data validation qualifiers were applied to results where a QC nonconformance required qualification per EPA guidance. Qualified results and the specific reasons for data qualification are listed in each individual Data Validation Report. All Data Validation Reports are provided in **Appendix Q**.   A total of only 48 results out of 64,450 evaluated (0.074% of the total) were rejected and are not usable for project decisions. These rejected result values were removed from the database to prevent use during project decision making. Summaries of the method conformance, QC sample frequency, and data qualifications (including details concerning the rejected results) for each major test group or analytical fraction, per Section 8.3.2 of the QAPP, are provided as text and tables in **Appendix R**.

4.1.2 Quality Assurance Assessment

The project data quality objectives for measurement data were based on the assessment of precision, accuracy, completeness, sensitivity, comparability, and representativeness.

Precision is a measure of the degree to which two or more measurements are in agreement. Field precision was assessed through the collection and measurement of field duplicates at a rate of one duplicate per twenty analytical samples, per matrix, per sampling technique. Precision was measured through the calculation of relative percent difference (RPD). The objective for field precision RPDs was < 30% RPD for aqueous samples, and < 50% RPD for solid samples, where results reported at greater than five times the reporting limit. Precision in the laboratory is assessed through the calculation of RPD for duplicate samples, either as matrix spike/matrix spike duplicates (MS/MSDs) or as laboratory duplicates.

Accuracy is the degree of agreement between the observed value and an accepted reference or true value. Accuracy in the field was assessed through the use of negative controls such as trip blanks and equipment blanks and through the adherence to all sample handling, preservation, and holding time requirements. The objective for trip blanks and equipment blanks was that no target compounds should be present above the reporting limit. Laboratory accuracy was assessed through the analysis of laboratory method blanks as negative controls, and spiked samples such as matrix spikes and matrix spike duplicates (MS/MSDs), laboratory control samples (LCSs), and surrogate compounds, as positive controls. The objective for method blanks was no detected target compounds above the reporting limits (RLs) or Estimated Minimum Level (EML) for all isotope dilution analytes.

Precision and accuracy goals as defined in Table 1 of the QAPP were met for almost all samples. Criteria exceedances that resulted in data qualification are summarized in **Appendix R** by method. A very limited number of accuracy criteria exceedances resulted in rejection of results. Overall method precision and accuracy were excellent. Only 0.074% of the results were rejected based on quality control problems discovered during data validation.

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions, defined as the conditions expected if the sampling plan was implemented as planned.

Project completeness objectives were defined in Section 3.2.3 of the QAPP. The field completeness objective of >90% and the laboratory completeness objective of >95% for valid measurements were both met. Greater than 99.9% of the laboratory results were deemed valid and usable for project decisions.

Sensitivity of analytical data was demonstrated by laboratory reporting and detection limits. Nominal reporting and detection limits , presented in Tables 2 and 3 of the QAPP, were selected based on consideration of the applicable risk based project screening levels (PSLs) and the actual ability of the laboratory to attain reporting limits at these screening levels. Not all PSLs were obtainable using the conventional USEPA methods, but to maximize the usability of the data, any analytes detected below the reporting limit and above the method detection limit were reported and qualified as estimated by the laboratories.

Sensitivity goals were met for all target analytes where analytes were not detected and dilutions due to high concentrations of detected analytes or matrix interferences were not required. Occasionally nominal reporting limits for water samples were slightly elevated due to limited sample volume. Some sediment sample reporting limits were elevated by dry weight correction due to high moisture content.

Comparability expresses the confidence with which one data set can be compared to another. Representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary.

Comparability and representativeness as defined in Section 3.2.5 and 3.2.6 of the QAPP were achieved by used of approved EPA methods and proper sampling per AECOM approved SOPs. Overall project data quality objectives were met and all results reported in data tables are suitable for project decision making.

4.2 Soil Sampling Results

4.2.1 Surface Soils

The surface soil sampling event was conducted in February, 2013 with the exception of location SUS22, which was sampled in June, 2013 due to access issues. With the exception of one (1) sample, surface soil samples were collected at a depth from surface to 1 foot below ground surface (ft bgs) except where surface material or other non-soil debris (asphalt, road gravel) was present at surface; one (1) sample (SUS21) was sampled at a depth of 1.0 – 1.75 ft bgs due to surface material. A total of twenty-five (25) normal samples (designated by the letter "N") and one (1) duplicate sample (designated by the letter "R") at SUS01 were collected. The sampling interval and date and time of sample collection are presented in **Table 4-1** along with the full analytical results and data statistics. Surface soil sampling locations are shown on **Figure 2-1**.

All samples were analyzed for metals, VOCs, PAHs, TPHs [gasoline range organics (GRO), diesel range organics (DRO), and oil range organics (ORO)], and PCBs. A subset of 10 samples was analyzed for SVOCs, pesticides, and dioxins/furans. Inorganic and organic COI distribution in surface soils are depicted in **Figure 4-1** and **Figure 4-2**. The following paragraphs provide a discussion of the analytical results:

Inorganics

A portable XRF instrument was used to screen surface and subsurface soils for metals per the project SAP and following the guidance provided in EPA Method 6200. Results for XRF screening analyses are provided in **Table 4-2**. The surface and subsurface soils were also analyzed by definitive methods (ICP-MS and CVAAS) at the TestAmerica-Pittsburgh laboratory for the full suite of project metal analytes. The comparability of the field XRF and fixed lab metals data for surface and subsurface soils were evaluated by least squares linear regression analysis using log transformed results per EPA Method 6200. The regressions for copper, lead, vanadium, and zinc had correlation coefficient values >0.7 and were therefore acceptable for screening level data per EPA 6200 Section 9.7. Correlation plots for these metals are provided in **Appendix U**. The correlations for arsenic, antimony, barium, cadmium, chromium, cobalt, iron, mercury, nickel, and selenium did not meet the minimum correlation coefficient requirement, however the XRF results generally over-predicted the fixed lab definitive method results and were sufficiently sensitive in most cases to provide information about any metals hotspots. No XRF data was collected for aluminum, beryllium, magnesium, thallium, or sodium due to inherent limitations of the XRF technique for light metals and instrument calibration. Selected samples were submitted for definitive metals analysis based on the XRF screen results for lead and vanadium. An additional set of 64 subsurface soil samples screened were also analyzed by definitive lab methods for metals in soil to reduce reliance on the XRF data, exceeding the 20% frequency for confirmatory samples planned in the SAP Table 4. The nature and extent discussion below is based on the results of the laboratory testing.

Most metals detected across the Site surface soils were within the background ranges identified in the preliminary RI background analysis (it should be noted that background will be revised in conjunction with an additional sampling phase and comparison of site data to this revised background will be performed at that time and documented in a revision to this report); however arsenic, chromium, cobalt, lead, and vanadium concentrations exceeded their respective screening levels (**Table 4-1**). Screening level exceedances of arsenic and chromium were more widespread, while cobalt, lead and vanadium exceedances were highly localized. The maximum concentration of chromium and vanadium were detected at SUS08 within TA #1 (former sludge dewatering area). The finding of elevated concentration of vanadium is consistent with the findings reported in the EPA 2009 SI Report for this area. The maximum concentrations and the only screening level exceedances for cobalt and lead were reported at location SUS01. The distribution of inorganic COIs in surface soils is depicted in **Figure 4-1**.

VOCs

Low concentrations of VOCs associated with fuels and solvents were detected at isolated locations and will be further evaluated and investigated as needed in an additional field investigation. The detections include benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds at three (3) locations, SUS02, SUS06, and SUS23; 1,1,2,-Trichloroethane (1,1,2-TCA) and 1,2-Dichloroethane (1,2-DCA) at SUS15; perchloroethylene (PCE) at SUS21; 1,2,3-trichlorobenzene at SUS04, 4-Methyl-2-Pentanone at SUS15 and acetone at six locations. VOCs detected in surface soil samples are limited in extent and all were below screening levels (**Table 4-1**).

SVOCs/PAHs

Priority pollutant PAHs are the most commonly detected SVOCs in the surface soils. PAHs were detected in every surface soil sample collected. Most PAHs were below project screening levels, only three of the PAHs exceeding screening levels in surface soils were identified as the COIs (Benzo(a)pyrene, Benzo(b)fluoranthene, and Dibenzo(a,h)anthracene). Total PAH concentrations are generally less than 10 mg/kg, except for four locations SUS12 (20,948 µg/kg), SUS19 (31,336 µg/kg), SUS 21 (23,581 µg/kg) and SUS24 (34,172 µg/kg).

All SVOCs detected, other than PAHs in surface soil samples, were below screening levels. The most common SVOC analytes detected besides PAHs were 2-Methylnaphthalene, bis-(2-Ethylhexyl)phthalate, and Carbazole.

GRO/DRO/ORO

All twenty-five (25) locations were analyzed for GRO, DRO, and ORO. GRO was detected at two (2) locations ranging from 250 to 350 mg/kg (SUS02). These values are below the D.C. Underground Storage Tank (UST) Management Division Petroleum Contaminated Soil Quality Standards for GRO (814 mg/kg). DRO was detected at ten (10) locations at concentrations ranging from 13 J to 180 J mg/kg (SUS05), all of which were below the D.C. Petroleum Soil Quality DRO standard of 960 mg/kg. ORO was detected at all twenty-five (25) locations at concentrations ranging from 25 to 1,800 mg/kg. The maximum concentration of 1,800 mg/kg was detected at SUS05 and SUS08 and is below risk-based screening level. These two locations are within TA#3 and TA#1, respectively.

PCBs

PCBs at low concentrations were detected at 22 of the 25 locations sampled. Total PCB concentrations exceeding the screening level were detected at six locations with the maximum concentration (7.2 mg/kg) occurring at SUS21 near TA #12. The next three highest concentrations were detected within the former PCB cleanup areas (TA#4, TA#5, and TA#7) and are potential residuals from former cleanups (**Figure 4-2**).

Three (3) PCBs Aroclors (A-1242, A-1254, and A-1260) were detected in surface soil samples. A-1254 was predominant in TA#5 and was also detected to be the predominant Aroclor in the Cooling Tower materials. A-1242 was predominant in the other two former cleanup areas (TA#4 and TA#7) as well as in the sample collected near Bldg. 57 (TA#12). In general, PCBs appear to occur as A-1254 and A-1260 combination in the western portion of the Site, and as A-1242 and A-1260 combination in the eastern portion of the Site; these PCB distributions are preliminary and will be confirmed in an additional sampling event. USEPA 2009 SI reported a combination of A-1254 and A-1260 in soil samples collected in the former sludge dewatering area.

Additional surface and subsurface soils were sampled around Cooling Tower (CT) concrete basins under the RI/FS Work Plan Addendum #2. Preliminary results from delineation of PCB contamination in soils around the Cooling Towers (TA #5) indicated PCB contamination in surface soils exceeding 1.0 mg/kg at several locations up to 15 ft. away from the basins. The PCB impacts in soils at CT are believed to be a result of PCBs present in the CT materials. Results from this investigation were submitted to DOEE in connection with a separate Soil Removal Action Plan (RAP) (AECOM, 2014c). Pursuant to the RAP, all such affected surface soils will be removed from the site coincident with the removal of the cooling tower basins which is expected to take place within the next several months, and therefore are not addressed further as part of the RI/FS.

Pesticides

Low parts per billion level concentrations of pesticides were detected in surface soils. Pesticides detected more commonly included: DDT metabolites (4,4’-DDD, 4,4’-DDE, and 4,4’-DDT), dieldrin, endosulfan sulfate, heptachlor epoxide, and methoxychlor. All pesticide concentrations were below screening levels (**Table 4-1**).

Dioxins/Furans

All of the dioxin and furan compounds were detected at parts per trillion concentration levels in all ten soil samples analyzed. TCDD Toxicity Equivalents (TEQs) ranged from 1.27 to 58.7 picograms per gram (pg/g). The TCDD TEQ for human health (22 pg/g) was exceeded at four locations with the maximum concentration present at SUS-11. Three of the four highest calculated TEQs (samples SUS08, SUS10, and SUS11) were collected from sampling locations along to the northern perimeter of the Site close to the former trash incinerator facility (now D.C. DPW Solid Waste Transfer Facility). Although this distribution was observed, additional evaluation of potential off-site sources of site dioxin concentrations will be performed as a part of an additional field investigation.

4.2.2 Subsurface Soils

The sub-surface soil sampling included a total of forty-six (46) DPT borings conducted in two events, from March 13, 2013 through April 04, 2013 and again from May 14, 2013 through June 2013. The March-April event included soil samples collected at depths up to 15 ft bgs as well as below 15 ft bgs for the purpose of investigating the ERI anomalies identified previously, samples were analyzed for VOCs, SVOCs, PAHs, metals/Mercury, GRO, DRO, ORO, and PCBs . The May event included soil samples collected at three depth horizons, approximately 5, 10, and 15 ft bgs. Samples were analyzed for VOCs, PAHs, Metals/Mercury, GRO, DRO, ORO, pesticides, PCBs and Dioxins/Furans. A total of one hundred forty-eight (148) sub-surface soil samples were collected at multiple depths at these locations; one hundred forty-three (143) normal samples and five (5) duplicates. Not all samples were analyzed for all analytes; **Table 2-2** summarizes the data collection program.

ERI activities coupled with the data collected from DPT borings to confirm composition of geophysical anomalies observed during ERI indicated that there were no likely free product [light non-aqueous phase liquids (LNAPL) or dense non-aqueous phase liquids (DNAPL)] pools at the locations investigated. PID screening conducted on site and visual observations made as part of lithologic logging did not identify any LNAPL/DNAPL zones on Site. A technical memorandum summarizing ERI survey results is provided in **Appendix E** and PID reading collected during soil borings are provided on the boring logs located in **Appendix F**.

Analytical results for subsurface soil samples are summarized in **Table 4-3** and subsurface sampling locations are shown in **Figure 2-1**. The following paragraphs provide a discussion of the analytical results:

Inorganics

A total of 65 samples were collected at various depths from thirty-four (34) locations across the Study Area and analyzed for inorganics. For subsurface soil samples, arsenic, chromium, cobalt, lead, manganese, and thallium concentrations exceeded their respective screening levels (**Table 4-3**). Cobalt, lead and thallium exceeded screening levels at only one location each and, therefore, are highly localized. Chromium exceedances were more widespread across the Site followed by arsenic and manganese. The distribution of inorganic COIs is shown in **Figure 4-3**. The nature and extent of inorganics in Site soils will be further evaluated in the upcoming additional field investigation.

VOCs

A total of 67 samples were collected at various depths from forty-one (41) locations across the Study Area and analyzed for VOCs. VOC detections in subsurface soils were very limited and none of the detected analytes exceeded the screening levels. Majority of the detections occurred at two locations, DP-12 and DP-39 and included fuel related compounds. Acetone, a common laboratory contaminant, was detected in 15 of the 67 samples analyzed.

SVOCs/PAHs

A total of seventy-five (75) samples, seventy-two (72) normal and three (3) duplicate samples were collected at various depths from twenty-five (25) locations across the Study Area and analyzed for PAHs. Priority pollutant PAHs are the most commonly detected SVOCs in the surface soils. PAHs were detected in 40 of the 75 soil samples analyzed. Most PAHs were below project screening levels, only five of the PAHs exceeded screening levels in subsurface soils (Benzo(a)anthacene, Benzo(a)pyrene, Benzo(b)fluoranthene, and Dibenzo(a,h)anthracene, and Indeno (1,2,3-cd) pyrene). Total PAH concentrations ranged from 3.6 to 180,000 µg/kg, with a mean concentration of 9,800 µg/kg. Only five locations (DP-04, DP-12, DP-19, DP-39, and DP-41) exhibited total PAH concentrations greater than the mean value. The maximum concentrations were reported at DP-19 (see **Figure 4-4**). All locations, except for DP-19, are in the western portion of the Site. PAHs were largely detected in the top 10 ft. of the subsurface indicating that historical fill and/or spills may be a source of these PAHs. PAHs in soil will be addressed in an additional sampling phase.

A total of twenty-eight (28) samples, twenty-seven (27) normal and one (1) duplicate samples were collected at various depths from ten (10) locations across the Study Area and analyzed for SVOCs. SVOCs detected in sub-surface soil samples were all below screening levels. Benzaldehyde, bis-(2-Ethylhexyl)phthalate, Butylbenzylphthalate, and Diethylphthalate were the most common analytes detected.

GRO/DRO/ORO

A total of one hundred thirty-nine (139) samples; one hundred thirty-four (134) normal samples and five (5) duplicates were collected at various depths from forty-six (46) locations across the Site and analyzed for GRO, DRO, and ORO. GRO was detected in eight (8) normal samples at concentrations ranging from 60 to 38,000 µg/kg, all of which are below the human health screening level. DRO was detected in twenty-four (24) normal samples at concentrations ranging from 10 to 4,700 mg/kg. ORO was detected in sixty-five (65) including normal and one associated duplicate samples at concentrations ranging from 11 to 17,000 mg/kg. All of the maxima were reported in a sample collected from 2.5 to 3.5 ft bgs at SB-3. DRO and ORO concentrations at SB-3 exceeded the screening levels. Detected concentrations at all other locations were below the screening limits. Olfactory observations or PID readings beyond the 5 ft level did not indicate any oil contamination.

The SB-3 sample location is within the Cooling Tower soil excavation footprint that is slated for excavation in accordance with the Cooling Tower Basin Soil Removal Action Plan approved by DOEE on July 29, 2015. Pepco will collect two confirmatory side wall/step out samples at the end of excavation limits, one to the north and one to the east each at 2.5 to 3.5 foot level and analyze for Total Petroleum Hydrocarbons – Diesel Range Organics (DRO) and Oil Range Organics (ORO). Sample results will be shared with DOEE to determine the need for further action.

PCBs

Low levels of PCBs were detected in 49 of the 139 samples analyzed. Total PCB concentrations exceeding the screening level were detected at two locations, with the maximum concentration (3.1 mg/kg) occurring at DP-44 (2.5-3.5 ft bgs) near TA #11 and the next highest concentration of 1.1 mg/kg detected at DP-15 (9.5-10 ft bgs). DP-15 sample was collected in a grassy area adjacent to Building #75 (**Figure 4-4**).

Predominant Aroclor combinations detected in subsurface soils were Aroclor 1254 and Aroclor 1260 mixtures near the Cooling Towers (TA#5) and in the western portion of the Site. Aroclor 1248 and Aroclor 1260 combinations were detected in other areas. Unlike the surface soils, Aroclor 1242 was not detected in any of the subsurface soil samples.

As noted above, additional surface and subsurface soils were sampled around Cooling Tower (CT) concrete basins under the RI/FS Work Plan Addendum #2. Preliminary results from delineation of PCB contamination in soils around the Cooling Towers (TA #5) indicated PCB contamination in subsurface soils exceeding 1.0 mg/kg at several locations in the area below and immediately surrounding the basins. The PCB impacts in soils at CT are believed to be a result of PCBs present in the CT materials. Results from this investigation were submitted to DOEE in connection with a separate Soil Removal Action Plan (RAP). Pursuant to the RAP, it is expected that most of the affected subsurface soils will be removed from the cooling tower area with the implementation of the DOEE-approved RAP. Any subsurface soils containing PCBs above 1.0 mg/kg that may remain after the removal of the basins will be addressed in an additional phase of sampling.

Pesticides

Low parts per billion level concentrations of pesticides were detected in subsurface soils. Pesticides detected more commonly included: DDT metabolites (4,4'-DDD, 4,4'-DDE, and 4,4'-DDT), endosulfan sulfate, endrin, endrin aldehyde, lindane, and trans-chlordane. All detected pesticide concentrations were below screening levels (**Table 4-4**).

Dioxins/Furans

Dioxin and furan compounds were detected at parts per trillion concentration levels in all 12 soil samples analyzed. TCDD Toxicity Equivalent (TEQ) ranged from 0.0367 to 6.56 pg/g. The TCDD TEQ for human health (22 pg/g) was not exceeded in any of the 12 subsurface soil samples collected.

4.2.3 Soils Summary

Most of the inorganics and all of the pesticides, TPH fractions, VOCs, and SVOCs except for a limited number of PAH compounds, were below their respective screening levels in surface soils. Based on the results of the preliminary risk assessments performed for this draft RI, the following constituents exceeded the screening levels and therefore were identified as COIs for surface soils: arsenic, chromium, cobalt, lead, vanadium, PCBs, three PAHs [benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h) anthracene], and TCDD-TEQ. Upon the completion of the additional field sampling to address remaining data gaps and uncertainties, the COI analysis will be updated and, as a result, this list of COIs will be modified accordingly.

Results for subsurface soil are similar to surface soil. Most of the inorganics and all of the pesticides, VOCs, and SVOCs except for a limited number of PAH compounds, were below their respective screening levels. Based on the results of the preliminary risk assessments performed for this draft RI, the following constituents exceeded the screening levels and therefore were identified as COIs for surface soils: arsenic, chromium, cobalt, lead, manganese, thallium, PCBs, five PAHs [Benzo(a)anthacene, Benzo(a)pyrene, Benzo(b)fluoranthene, and Dibenzo(a,h)anthracene, and Indeno (1,2,3-cd) pyrene], and TPH fractions. As noted above, this list is subject to change pending the completion of the additional sampling event and re-evaluation of the current dataset in concert with the additional data generated.

4.3 Groundwater

Groundwater sampling was conducted in two phases, DPT groundwater sampling during Phase II followed by monitoring well installation and sampling during Phase III. The screening level DPT groundwater results were used to identify monitoring well locations as described in RI/FS Work Plan Addendum #1. Direct push groundwater sampling was conducted from March through June 2013 as part of the Phase II the DPT subsurface investigation. A total forty-seven (47) groundwater samples were collected from DPT subsurface sampling points using a screen point sampler. At most locations, one groundwater sample was collected at the first occurrence of groundwater, however at sixteen (16) locations, a second sample of groundwater was collected at a lower depths. Sampling locations are shown in **Figure 2-1**. The groundwater samples were analyzed for metals and inorganics, VOCs, SVOCs, TPH fractions, PCBs, pesticides, and dioxins/furans. Analytical results along with data statistics are summarized in **Table 4-4**.

Based on the DPT groundwater results, a total of 15 pairs of groundwater monitoring wells were installed to verify the screening-level data collected during the DPT investigation. Phase III groundwater sampling was conducted in November 2014 following well installation and development. A total of thirty (30) newly installed nested monitoring wells were sampled; fifteen (15) shallow wells screened in the Upper Water Bearing Zone (referred by the prefix of “A”) and fifteen lower monitoring wells screened in the lower water bearing zone (referred by the prefix “B”). Monitoring well locations are shown in **Figure 2-1**. Analytical results along with data statistics are summarized in **Table 4-5**.

Due to the highly variegated nature of the Patapsco Formation at the Site and the observed presence of lenticular beds of fines within coarse-grained deposits, it was necessary for the well screens to intersect one or more layers of silt or clay in nearly every well. As a result of the fine-grained materials within the screened intervals, the five-well-volume minimum pumped during well development is likely not to have removed all entrained fine particulates from the vicinity of the screen. This is a possible contributing factor to the high turbidities observed in the groundwater samples, and consequently it is proposed that the wells be redeveloped before any additional sampling is conducted.

The District of Columbia Municipal Regulations (DCMR) Title 21, Section 1155 specify numerical criteria for groundwater in the District. The groundwater concentrations detected at the Site are compared to these numerical criteria (**Table 4-4 and Table 4-5**). Screening levels chosen from a combination of DC Surface Water Quality Standards, USEPA Ambient Water Quality Criteria, and/or USEPA Regional Screening Levels for tap water (as noted in the data tables) were used where the numerical criteria from DC are not available. These screening levels are used for comparison and discussion purposes only, as groundwater at the Site is not used for drinking water or other purposes. As discussed in Section 3.0, that Site groundwater discharges to the Anacostia River. As such, the risk assessments have evaluated groundwater discharges to surface water as identified in the groundwater samples collected from the four near-shore monitoring well pairs (MW1A/B, MW2A/B, MW3A/B, and MW4A/B). The following paragraphs discuss Phase II and Phase III groundwater results for each analyte group:

Inorganics

The distribution of inorganic COIs in monitoring wells is shown in **Figure 4-5.** A number of metals and mercury exceeded screening levels in DPT samples on a total metal basis. However, many fewer inorganic constituents exceeded screening levels in samples collected from the monitoring wells, eliminating mercury, arsenic, barium, copper and lead. This indicates the effect of turbidity caused by suspended soil particles in the DPT samples and unfiltered, total metal samples. Filtered samples are thus indicative of true dissolved fractions for decisions involving groundwater/surface water impacts.

The dissolved metals results for Phase III monitoring well samples indicate that cadmium, cobalt, iron and manganese exceeded the screening levels in groundwater in both UWZ and LWZ. These results are consistent with Phase II DPT groundwater results. Cadmium was detected in a total of three monitoring wells with the maximum concentration and screening level exceedance in MW-15B, upgradient Site well. Cobalt, iron and manganese were more widely detected. Iron and manganese are natural elements and higher concentrations often result from changes in redox conditions in the subsurface. Cobalt is present in high strength steels, alloys, and some paint pigments. The dissolved cobalt concentrations on Site range from 0.2 to 80 μg/L, with the maximum concentration occurring at the upgradient well, MW-15B. Although Site contribution to cobalt in groundwater cannot be ruled out, it should be noted that similar and higher concentrations in some instances were detected in the Kenilworth Park North (KPN) monitoring wells (Ecology and Environment, 2007). Specifically MW-12N on KPN, located upgradient of the Site, exhibited a cobalt concentration of 140 μg/L.

VOCs

Low concentrations of VOCs associated with fuels (BTEX compounds, and MTBE); chlorinated solvents [tetrachloroethene (PCE) and its daughter products trichloroethene (TCE), cis-1,2-dichloroethene (cis-DCE) and vinyl chloride(VC)]; common laboratory artifacts such as acetone, methylene chloride and carbon disulfide; and trihalomethanes (bromodichloromethane, dibromochloromethane, and chloroform) were detected. All compounds with the exception of PCE, TCE and MTBE were below screening levels in all samples. These results are consistent between Phase II and Phase III groundwater sampling results.

MTBE was detected in 31 of 63 Phase II DPT samples, with four locations (DP-29, DP-32, DP-33, and DP-45) exceeding the screening level. MTBE was also detected in 14 of the 32 Phase III groundwater samples, with only one well (MW-13B) exceeding the screening level. MTBE had been used in U.S. gasoline at low levels since 1979 to replace lead as an octane enhancer. Between 1992 and 2005, MTBE had been used at higher concentrations in some gasoline to fulfill the oxygenate requirements set by Congress in the 1990 Clean Air Act Amendments. MTBE was a constituent in gasoline dispensed at the site and the observed concentrations will be more fully delineated in an additional sampling phase.

During the Phase II investigation, PCE, TCE, cis-DCE, and VC were detected in 15, 6, 5 and 1 of the 63 samples, respectively. When subsurface conditions are favorable, biodegradation takes place sequentially from PCE to TCE to cis-DCE to VC. The three degradation products TCE, cis-DCE, and VC are referred to as PCE daughter products. The maximum concentrations of PCE (160 μg/L), TCE (12 μg/L) and cis-DCE (9.2 μg/L) occurred at DP-09. Only PCE and TCE concentrations at DP-09 exceeded the screening levels. and were the only screening level exceedances. VC was detected at DP-19 at a concentration of 1.0 μg/L, below its screening level. DP-09 and DP-19 are located along the southern property boundary of the Site. These findings prompted a comprehensive source investigation. The source investigation was performed as described in the RI/FS Work Plan Addendum #1 (AECOM, 2014a). PCE and daughter products were detected in two monitoring wells (MW-09 and MW-01) at concentrations exceeding the PCE and TCE screening levels. The presence of PCE and TCE in the DP-09 area groundwater is attributed to a potential off-site source to the south of the Site. Results of the source investigation are further described in **Section 4.9**.

SVOCs/PAHs

All sixteen (16) PAHs were detected in DPT groundwater samples. PAHs were detected in 38 of the 62 samples analyzed. Total PAH concentrations in groundwater ranged from 0.036 to 30 μg/L, with the maximum concentration detected at DP-37 within TA#13. The arithmetic average of total PAH concentration is 2.4 μg/L. This average concentration was exceeded at five locations: DP-27, DP-28, DP-30, DP-37, and DP-39. Three of these locations (DP-27, DP-37 and DP-39) are located in and around TA#13. Permanent monitoring wells were installed during Phase III to verify the detection of various PAHs in UWZ and LWZ.

During Phase III sampling, PAHs were detected in eight of the 32 samples (MW-01 A and B, MW-02 A and B, MW-07A, MW-08A, and MW-12A and B). The distribution of Total PAHs in monitoring wells is shown in **Figure 4-6.** All of these wells, with the exception of MW-12, are located in the western portion of the Site. The total PAH concentrations ranged from 0.039 to 16 μg/L, with the maximum detected at MW-02A. Total PAH concentration at MW-01, 02 and 08 is primarily or entirely due to naphthalene. Total PAHs at MW-07 and MW-12 are entirely due to acenaphthene and 2-methyl naphthalene, respectively. The detection of low concentrations of some high molecular PAHs during Phase II DPT sampling could be a result of the drag-down of contaminated fine soil particles from zones above the sampling interval. Irrespective of the care taken to install temporary sample points, DPT sampling methods sometimes introduce a positive bias in groundwater samples due to drag-down.

Naphthalene exceeded screening levels in all six wells where it was detected. Except for one (1-1 biphenyl), all SVOCs were either detected below the screening levels or not detected in groundwater samples. The compound, 1-1 biphenyl was detected and exceeded screening value only in MW-12A.

GRO/DRO/ORO

Only Phase II DPT groundwater samples were analyzed for TPH fractions. GRO was detected only at DP-32 at a concentration of 880 μg/L. This is consistent with the detection of MTBE at this location as MTBE is a gasoline additive. DRO was detected in 8 of the 62 samples at 260 to 540 μg/L, with the maximum detected at DP-46. ORO was detected in 15 of the 62 samples at 230 to 1,900 μg/L, with the maximum detected at DP-43 in TA#4.

PCBs

During the Phase II DPT sampling, PCBs were detected at eight of the 62 samples analyzed. All of these eight locations (DP-03, 05, 07, 08, 27, 37, 38, and 41) are located in the western portion of the Site. Samples collected from monitoring wells during Phase III indicated PCB presence in MW-07A (in Target Area #1) and MW-08B (near TA #5). Aroclor 1242 was detected in MW-07A at 0.034 μg/L. Aroclor combination of 1254 and 1260 at a total concentration of 0.11 μg/L was detected in MW-08B.

The distribution of Total PCBs in monitoring wells is shown in **Figure 4-6.** It is suspected that the PCB detections in monitoring well samples are false positives affected by the visual turbidity observed during sampling. Monitoring well turbidity issues will be addressed in the upcoming additional field investigation. PCBs are hydrophobic compounds with higher log Kow values (>2.5) that have very low water solubility. The logarithm of the n-octanol/water partition coefficient (log Kow) is a measure of a compound’s tendency to remain dissolved in water. The higher the Kow value, the more likely the chemical is to partition from the water onto suspended soil/organic particles. The fact that the concentrations of these compounds detected at the Site exceed their water solubility indicates that the measured groundwater concentrations may have been artificially inflated by turbidity. As noted above, monitoring well turbidity issues will be addressed in the upcoming additional field investigation.

Pesticides

During Phase II DPT investigation, several pesticides (DDT metabolites, cis and trans chlordane, dieldrin and heptachlor epoxide) were detected primarily in the mid to eastern portion of the Site (DP-09, 10, 11, 17 and 24). However, Phase III monitoring well sampling did not confirm many of these detections. The monitoring well data indicated screening level exceedances for 4,4'-DDT, heptachlor epoxide, and trans-chlordane in the wells primarily in the mid to western portion of the Site.

There are no known sources of organochlorine pesticides on the landside portion of the Site. However, a more detailed account of potential historical pesticide storage and use on site will be included in an updated CSM to be prepared in conjunction with the additional field investigation. The pesticides DDT, DDE, DDD, and gamma-chlordane (or trans-chlordane) were widely used historically in urban areas for mosquito and termite control. They are persistent in soils and commonly detected in urban soils and sediments many decades after application. The groundwater samples from monitoring wells were also visually turbid, raising the possibility that the measured parts-per-trillion level concentrations may have been artificially inflated by turbidity. As noted, monitoring well turbidity issues will be addressed in the additional field investigation.

Organochlorine pesticides were analyzed by gas chromatography with electron capture detection (GC/ECD) per EPA Method 8081. PCB congeners are a well-documented interference in the pesticide analysis because they survive the typical cleanups, and are detected by the ECD. The probability of some false positives for pesticides from peaks on both the primary and secondary columns detectors when Aroclors are present is relatively high. All significant detections of organochlorine pesticides in the presence of PCBs, i.e. ones that may drive remedial decisions, should be confirmed by a more selective and specific analytical technique such as GC/MS, GC/MS-MS, or GC/HRMS.

Dioxins/Furans

Dioxins and furan compounds were detected in all 11 of the samples collected during the Phase II investigation at TCDD TEQs ranging from 0.000762 to 0.643 pg/L, with the maximum TEQ reported at location DP-08 (TA #1). Four of the Phase II locations (DP-02, 08, 09 and 17) exceeded the human health-based TEQ of 0.051 pg/L.

During Phase III, 14 of the 17 samples collected exhibited TEQs ranging from 0.00711 to 14.1 pg/L with the maximum TEQ reported at MW-12A. Eight of the monitoring wells (MW-01A, 04A, 07A, 07B, 09A, 09B, 11A, 11B, 12A and 12B) exhibited TEQ levels exceeding the human health screening level of 0.051 pg/L.

The detected concentrations appear to be randomly distributed throughout the Site, with no definitive pattern. The groundwater samples from monitoring wells were also visually turbid raising the possibility that some of the measured concentrations may have been artificially inflated by turbidity. Although these parts-per-quadrillion levels do not appear to be Site-related, the dioxin concentrations will be further investigated as a part of the additional field investigation. Monitoring well turbidity issues will also be addressed in the additional field investigation.

4.4 Storm Drain Sampling Results

Storm drain water and residue sampling was conducted on October 7th and 8th, 2013, respectively. The locations of the storm drain samples are shown on **Figure 2-2.** Analytical results and statistics for the storm drain water and residue samples are provided in **Table 4-6** and **Table 4-7**, respectively. Eight normal water samples and one duplicate surface water sample (at location SDPEPR1) were collected. Sample SDW101N was a weighted composite of water from four storm sewer manholes on the west side of the former power plant building that drain to Outfall 101. Four normal storm drain residue (sediment) samples and one duplicate residue sample (at location SDPEPR5) were collected.

Storm drain water samples were analyzed for total and dissolved metals, VOCs, PAHs, TPH (GRO, DRO, and ORO), pesticides, and PCBs. Storm drain residue samples were analyzed for metals, VOCs, PAHs, TPH (GRO, DRO, and ORO), pesticides, and PCBs. Analytical methods for the storm drain samples are provided in **Table 2-2**. Concentrations of inorganic and organic constituents of interest in the storm drain samples are shown on **Figure 4-7** and **Figure 4-8**, respectively. No screening levels were defined for storm drain water and storm drain residue because there is little or no direct contact between these media and human or ecological receptors. Rather, as discussed below, the storm drain sampling results are used in assessing whether and to what extent Site storm water discharges may be a past or present source of contaminants to the river. Any associated risks to human or ecological receptors are addressed as part of the overall risk assessments for the Waterside area.

Recently, Pepco conducted a closed-circuit television (CCTV) inspection of the storm drains and identified several areas with accumulated sediments. Pepco subsequently completed a clean out of the entire storm drain system, and removed all accumulated sediments (approximately 47 cubic yards) for off-site disposal. Therefore, the storm drain samples collected during the RI are no longer representative of conditions within the storm drain system. Pepco will document the testing performed to determine the appropriate disposal approach for these sediments, and the analytical results of this testing will be included in the Work Plan Addendum to be prepared for the upcoming additional phase of field work.

Inorganics

The analytical data indicate levels of metals in site storm water and storm drain residue consistent with storm drain sampling conducted during an EPA Multi-Media Inspection (USEPA, 1997). Consistent with the

1997 EPA sampling event (USEPA, 1997), the metals exhibiting the highest concentrations in storm drain residue were lead (3200 mg/kg in sample SDR101N) and zinc (3200 mg/kg in SDRPEPR4N). The distribution of selected metals in storm drain samples is shown on **Figure 4-7**.

VOCs

Very low levels of VOCs were detected in residue samples from all four (4) sampling locations and in one (1) storm water sample. All VOC detections were at levels near the typical laboratory detection limits, all were qualified as estimated values, and none were above 2 parts per billion (ppb) in residue or surface water.

PAHs

PAHs were detected in all storm drain surface water and residue samples. The mean concentration of total PAHs (sum of 16 EPA priority PAHs) in stormwater samples was 2.4 µg/L. The mean concentration of total PAHs in residue was 24 mg/kg, and the maximum detection of total PAHs in residue was 40 mg/kg in sample SDR101N to the west of the former power plant building. The PAH with the highest mean detection among storm drain residue samples was fluoranthene. To place the PAH sampling results in context, a revised background study, to be completed in conjunction with the additional field investigation, will characterize background PAH concentrations for the Site vicinity. The distribution of total PAHs in storm drain samples is shown on **Figure 4-8**.

GRO/DRO/ORO

At least one class of TPH (GRO, DRO, or ORO) was detected in every storm drain water and residue sample except for water sample SDWMH02N. The maximum concentrations of DRO and ORO detected in storm drain residue were 3300 mg/kg and 5800 mg/kg, respectively, both in sample SDRPEPR4N in the southeast corner of the site. Sample SDR101N contained the highest detected concentration of GRO (1.6 mg/kg). The maximum concentrations of DRO and ORO detected in stormwater were 1.2 mg/l and 3.3 mg/l, respectively, both in sample SDWPEPR4N. There were no detections of GRO in any storm drain surface water samples. The observed detections of TPH in the storm drain system will be further investigated in the additional field investigation.

Pesticides

At least one pesticide was detected at low levels in every storm drain water and residue sample except for water sample SDWMH02N, and most storm drain samples contained three or more pesticides. The pesticide exhibiting the highest concentration in stormwater was 4,4'-DDT (0.02 µg/l in sample SDWPEPR3N). The pesticide exhibiting the highest concentration by far in storm drain residue was Methoxychlor (11 mg/kg in sample SDRPEPR5). The data validation effort qualified this result with a "JX" qualifier, meaning the analyte was not confirmed and the result is a probable false positive. Excluding this detection, levels of pesticides in storm drain residue ranged from <5 µg/kg to 120 µg/kg. The presence of low levels of pesticides in storm water runoff is typical of urban environments where pesticides have been historically used. However, a more detailed account of potential historical pesticide storage and use on Site will be included in an updated CSM to be prepared in conjunction with the additional field investigation. The distribution of selected pesticides in storm drain samples is depicted on **Figure 4-8**.

PCBs

Low levels of PCBs were detected in every storm drain residue and one storm drain surface water sample. The highest concentration of PCBs in storm drain residue was 960 µg/kg in sample SDR013N near the discharge point at Outfall 013. The PCBs at this location are comprised of Aroclor 1260 and Aroclor 1248. This pattern of Aroclors matches the Outfall 013 cove sediments, but does not match the pattern of Aroclors in residues from the other storm drain sampling locations (which are comprised of Aroclor 1260 and 1254). It is possible that the Outfall 013 sampling manhole location may have been impacted by river sediments at high tide due to backflow from the River into the Site storm drain system. Aroclor 1248 was not detected at the Outfall 013 manhole sampling location during the USEPA 1997 Multimedia Inspection Report (USEPA, 1997).

The one PCB detection in storm drain surface water was 0.45 µg/l in sample SDWPEPR3. The distribution of total PCBs (sum of Aroclors) in storm drain samples is depicted on **Figure 4-8**. In general, the PCB levels in the storm drain residue samples are significantly lower than the levels reported by the USEPA 1997 Multimedia Inspection Report (USEPA, 1997).

Following the additional field investigation and associated forensics analyses, a better understanding of on-Site and off-Site contributions to the storm drain residue will be obtained.

4.5 Anacostia River Surface Water

Surface water samples were collected at 20 locations (10 near-Site and 10 Background) between September 23 and October 3, 2013. Each surface water sample was analyzed for metals, PCBs and PAHs constituents. A subset of surface water samples were analyzed for metals, VOC, SVOC, pesticides, and dioxin/furan constituents. Details of the Waterside Investigation data collection program are provided in **Table 2-2**. The sample locations for the near-site Waterside Investigation Area are shown on **Figure 2-5**, and background sampling locations are shown on **Figure 2-6**. Analytical results for near-Site and Background surface water samples are summarized in **Tables 4-8** and **4-9**, respectively. The following paragraphs provide a discussion of the analytical results.

Inorganics

Dissolved and total arsenic, barium, and chromium exceeded human health as well as ecological screening levels in a number of near-Site samples as well as background samples. In addition, total recoverable iron and manganese also exceeded screening levels in all samples. Range of concentrations for all these metals were similar, indicating consistency with Site-specific background conditions. A preliminary background statistical evaluation for barium is presented in **Appendix V**. The background analysis will be revised and refined in conjunction with the proposed additional field investigation.

Dissolved cobalt exceeded its screening level at one near-Site location (SUW3C). Due to this one sample, the mean concentration for dissolved cobalt in near-Site samples is higher than the Site-specific background mean. However, the mean concentrations for total cobalt were similar for near-Site and Site-specific background samples. Total and dissolved copper concentrations in the near-Site samples are slightly elevated compared to background locations. Total copper exceeded its screening level at one location (SUW4B). Copper was the only compound that exceeded the screening level during 2009 USEPA Site Inspection, although the concentration was twice as high compared to current sampling results.

Organics

Two PAHs (anthracene and pyrene), one pesticide (4,4’-DDT), and dioxin human health TEQ exceeded screening values in the near-Site samples. Anthracene was detected and exceeded its screening level in only one near-Site sample (SUW4B). Pyrene, 4,4’-DDT and dioxin TEQ also exceeded screening levels in the background samples. Average concentrations observed for pyrene and 4,4’-DDT in near-Site and background samples are similar.

Dioxin TEQ exceeded its screening value in all near-Site and background samples tested. The average concentration of dioxin TEQ in near-Site samples (0.383 pg/L) is slightly elevated compared to background samples (0.271 pg/L).

Dieldrin and bis (2-ethylhexyl) phthalate exceeded the screening levels only in background samples. Dieldrin was not detected in the near-Site samples and bis-phthalate was detected in three of the six samples tested, but did not exceed screening values.

4.6 Anacostia River Sediments

Surface and subsurface sediment samples were collected at 56 locations (46 within the Study Area, referred to as “near-Site” samples, and 10 at Site-specific background locations) between November 5, 2013, and January 31, 2014. A total of 56 surface sediment samples and 208 subsurface sediment samples were collected. Surface sediment samples (collected from zero to six inches below sediment surface) and subsurface sediment samples (collected from one to nine feet below sediment surface) were submitted for laboratory analysis of VOC; SVOC; metals; pesticide, PCB, and dioxin/furan constituents. Each surface sediment sample was analyzed for metals, PCBs and PAHs constituents. Each subsurface sediment sample was analyzed for PCB and PAH constituents. A subset of the surface and subsurface samples were analyzed for metals, VOC, SVOC, pesticide, and dioxin/furan constituents. Not all samples were analyzed for all analytes. **Table 2-2** summarizes the data collection program.

Analytical results for surface and subsurface sediment samples are summarized in **Tables 4-10** and **4-11**. Near-Site and Site-specific background surface and subsurface sediment samples were screened against HHRA screening levels based on USEPA Regional Screening Level for Residential Soil and ERA screening values based on a hierarchy of freshwater sediment values (see **Tables 4-8** and **4-9**). Metals, PCB, PAH, and pesticide constituents were detected in numerous surficial and sub-surficial samples at concentrations in excess of screening levels; VOCs and dioxin/furan constituents were detected less frequently or not at all. **Figures 2-5** and **2-6** depict the near-Site and Site-specific background sediment sampling locations, respectively. PID readings collected during sediment characterization are provided on the boring logs located in **Appendix F**.

The Anacostia River has been impacted by a variety of historical and ongoing sources of chemical, physical, and biological stressors from point and non-point sources, including NPDES discharges, surface runoff, combined sewer and storm sewer outfalls, refuse disposal practices, tributary inputs, and atmospheric deposition (SRC and NOAA, 2000). The multitude of sources has resulted in diffuse distributions of some contaminants in sediments, including PAHs, metals, PCBs, and pesticides, with some localized hot spots (Wade et al., 1994; Velinsky et al., 1996; Velinsky et al., 2011). Due to the widespread presence of a variety of chemical contaminants in the Anacostia River watershed, the results of the human health and ecological risk assessments need to be evaluated in the context of regional background conditions. The following paragraphs provide a discussion of the sediment sampling analytical results in this context.

<u>Inorganics</u>

During the sediment sampling activities, a total of 68 Near-Site and 19 background sediment samples from a variety of sampling horizons were collected and submitted for analysis of metals (inorganic) constituents.

Metals constituents were reported at concentrations greater than the project screening criteria from sediment samples collected throughout the waterside investigation area, including background locations.

Near-Site sediment samples identified 12 analytes (aluminum, antimony, arsenic, cadmium, chromium, cobalt, lead, manganese, nickel, thallium, vanadium, and zinc) that exceeded HHRA screening levels (**Table 4-10**). Background sediment samples identified seven analytes (aluminum, arsenic, chromium, cobalt, manganese, thallium, and vanadium) that exceeded the HHRA screening levels (**Table 4-11**). Most of the reported analytes (aluminum, arsenic, chromium, cobalt, manganese, thallium, and vanadium) exceeded HHRA screening levels at both Near-Site and background locations. Furthermore, antimony, cadmium, lead, nickel, and zinc were identified at concentrations greater than the HHRA screening levels in less than 10 percent of the total number of Near-Site sediment samples.

Near-Site sediment samples identified 13 analytes (antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc) that exceeded ERA screening levels (**Table 4-10**). Background sediment samples (all depths) identified 11 analytes (barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc) that exceeded ERA screening levels (**Table 4-11**). Most of the reported analytes (barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc) exceeded ERA screening levels at both Near-Site and background locations. Furthermore, antimony and arsenic were identified at concentrations greater than the ERA screening levels in less than 10 percent of the total number of Near-Site sediment samples.

A preliminary evaluation of surficial sediment data relative to background conditions is presented in **Appendix V**. Additional evaluation will be conducted based on a revised background conditions assessment to be performed in conjunction with the additional field investigation.. This preliminary background evaluation included evaluation of the near-Site surficial sediment data relative to: (1) the background surficial sediment data collected as part of this RI effort (“site-specific background”), (2) regional data obtained from the NOAA DARPP Query Manager Database (queried in March 2015) (“regional background”); and (3) a sub-set of NOAA DARPP data from upstream of the Site (“regional conditions”).

This appendix includes semi-quantitative (pictorial box plots) and semi-quantitative (statistical) analysis. The box plots represent interquartile ranges (IQR) corresponding to quartiles or percentiles of the data (e.g., the 50th percentile represents the median of the data set – 50% of the data at concentrations greater than this value, and 50% of the data are at concentrations less than this value).

The box plot and statistical analyses were performed for the six organic COIs that were identified as COPCs in the risk assessment. The results of this comparison to the preliminary background suggested that the majority of these compounds are consistent with background conditions. However, this comparison will be updated using a revised background conditions assessment that will be prepared in conjunction with the additional field investigation. The preliminary results indicate the following:

- The IQR ranges of the six inorganic COPCs in surficial sediment (cadmium, chromium, copper, lead, nickel, and zinc), fall within the IQRs for site-specific background and regional conditions.
- The Site medians for several of these constituents are slightly greater than the site-specific background medians, but not the regional background or regional condition medians.
- Based on the population level tests, background and Site concentrations of copper, lead, and nickel are similar; however, the population level tests suggested that Site concentrations of cadmium, chromium, and zinc exceed background.
- Lastly, concentrations of all six inorganic COPCs are less than Background Threshold Values (BTVs) calculated from the Site-specific background data set.

These preliminary background evaluation findings suggest that the levels of inorganic COPCs in surface sediment adjacent to the Site are generally consistent with regional background and regional conditions, although levels of cadmium, chromium, and zinc in Site surface sediment may be elevated relative to Site-specific background. These findings are preliminary and subject to revision upon completion of the upcoming additional field investigation.

Based on frequency of detection and the preliminary background evaluation, the Site surficial sediment metals constituents identified as potentially differing from the Site-specific background condition include cadmium, chromium, copper, lead, nickel, and zinc. Detection ranges and means for near-Site and Site-specific background inorganic constituents are presented in the table below.

Inorganic COPC	**Near-Site Samples**		**Site-specific Background Samples**	
	Range (mg/kg)	**Mean (mg/kg)**	**Range (mg/kg)**	**Mean (mg/kg)**
Cadmium	0.24 – 60	2.8	0.015 – 2.5	0.83
Chromium	11 – 140	40	3.7 – 75	33
Copper	9.6 – 240	54	2.7 – 160	45
Lead	11 – 1,800	130	2.1 – 330	89
Nickel	7.7 – 180	38	5.7 – 50	27
Zinc	46 – 3,600	280	9 – 420	170

Laboratory results indicated that, in general, the highest concentration of COI metals in near-Site surface and subsurface sediment samples were detected in the cove where Outfall 013 and three other non-Site related outfalls are located (the “Outfall 013 cove area”). Isolated concentration of COI metals in subsurface sediments were identified downstream of Outfall 013 and north of the Benning Road Bridge.

The distributions of lead and nickel concentrations relative to ecological screening levels are shown in **Figures 4-14** and **4-15**, respectively. Lead and nickel were selected to illustrate a typical distribution pattern of inorganics.

VOCs

A total of 37 near-Site and 16 background sediment samples were collected and submitted for analysis of VOC constituents. VOC detections in surface and subsurface sediments were very limited. No analytes were reported in excess of the HHRA screening criteria. One analyte, acetone, was detected in five samples at concentrations greater than the ERA screening level. However, acetone is a common laboratory contaminant.

SVOCs/PAHs

During the sediment sampling activities, a total of 237 near-Site and 41 background surficial and sub-surficial sediment samples were collected and submitted for analysis of SVOC/PAH constituents. SVOC/PAH constituents in sediment were reported at concentrations greater than the HHRA and ERA screening levels both near-Site and background samples.

According to the 2009 USEPA SI Report, PAHs were detected in every sediment sample collected from the Anacostia River. The range of total PAH concentrations reported was from 2,020 µg/kg to a maximum concentration of 14,920 µg/kg. There was no distinct spatial distribution of the PAHs detected. The presence of PAHs in the Anacostia River appears to be indicative of ubiquitous levels in this vicinity of the Anacostia River rather than releases from the Site (USEPA, 2009). While PAH constituents are pervasive throughout the Anacostia River, concentrations in sediments generally decrease with depth for both Near-Site and background samples. However, concentrations at a few locations persist with depth and are present in samples from 7 to 9 ft below sediment surface.

Priority pollutant PAHs were the most commonly detected SVOCs in the sediments. The majority of SVOCs were below project screening levels. Near-Site and background sediment samples identified five SVOCs [benzo(a)anthacene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno (1,2,3-cd) pyrene] that exceeded HHRA screening levels.

Near-Site sediment samples identified 23 SVOC analytes (2,4-dimethylphenol, 4-methylphenol, di-n-butylphthalate, di-n-octylphthalate, and PAHs) at concentrations greater than the ERA screening levels in sediments. However, only di-n-butylphthalate and di-n-octylphthalate were reported for near-Site and not background sediment samples. Di-n-butylphthalate and di-n-octylphthalate were present in less than 10 percent of the total number of near-Site sediment samples. A common cause of phthalates is plasticizers used in a variety of commercially available plastic products (plastic bottles), which are abundant in the Anacostia River. The phenols (2,4-dimethylphenol and 4-methylphenol) can be attributed to background sources such as coal tars/creosote.

Total PAH concentrations ranging from 1,000 to 10,000 µg/kg were generally common in the near-Site and background sediment samples. Total PAH concentrations for near-Site samples ranged from 0.84 to 22,000 µg/kg. There were 96 near-Site samples that exhibited total PAH concentrations greater than the mean value of 4,200 µg/kg. Of 237 near-Site sediment samples collected, total PAH concentrations for 177 samples exceeded the ERA screening levels. The maximum near-Site concentration (22,000 µg/kg) was reported at SED-7E, proximal to Outfall 013 (see **Figure 4-9**).

Site-specific background samples exhibited total PAH concentrations that ranged from 3.5 to 71,000 µg/kg. There were 12 Site-specific background samples that exhibited total PAH concentrations greater than the mean value of 7,300 µg/kg. Total PAH concentrations for 31 Site-specific background samples (of 41 collected) exceeded the ERA screening levels. Three Site-specific background sample locations [SEDBACK 13 (70,560 µg/kg); SEDBACK 04 (35,133 µg/kg); and SEDBACK 15 (22,079 µg/kg)] exhibited total PAH concentrations in excess of the Site maximum (see **Figure 4-10**).

The findings of the preliminary background evaluation suggest that PAHs in near-Site surface sediment are consistent with Site-specific background, regional background, and regional conditions.

PCBs

During the sediment sampling activities, a total of 237 near-Site and 41 Site-specific background sediment samples were collected and submitted for analysis for PCBs.

The only Aroclors detected in near-Site and Site-specific background samples (Aroclors 1248 and 1260) were reported at concentrations greater than the ERA screening levels. The table below presents a summary of results statistics for these two Aroclors.

Aroclor	Near-Site Samples		Site-specific Background Samples	
	Range (µg/kg)	Mean (µg/kg)	Range (µg/kg)	Mean (µg/kg)
Aroclor-1248	2.3 – 4700	270	5.4 – 710	210
Aroclor-1260	0.98 – 1600	140	1.2 – 460	100
Total PCB Aroclors	0.98 – 6300	340	2.6 – 950	260

Of the 237 near-Site sediment samples analyzed for PCBs, Aroclor 1248 and/or 1260 were detected in 135 and 180 samples, respectively. Aroclor 1248 and Aroclor 1260 were the only Aroclors detected in near-Site sediments. Aroclor 1248 concentrations ranged from 2.3 to 4,700 µg/kg, with a mean concentration of 270 µg/kg for near-Site samples; 45 samples exhibited concentrations greater than the mean value. Aroclor 1260 concentrations ranged from 0.98 to 1,600 µg/kg, with a mean concentration of 140 µg/kg for near-Site samples; 54 samples exhibited concentrations greater than the mean value.

Of the 41 Site-specific background sediment samples analyzed for PCBs, Aroclor 1248 and/or 1260 were detected in 18 and 20 samples, respectively. Aroclor 1248 concentrations ranged from 5.4 to 710 µg/kg, with a mean concentration of 210 µg/kg for Site-specific background samples; 6 samples exhibited concentrations greater than the mean value. Aroclor 1260 concentrations ranged from 1.2 to 460 µg/kg, with a mean concentration of 100 µg/kg for Site-specific background samples; 7 samples exhibited concentrations greater than the mean value.

Total PCBs were reported at concentrations greater than the HHRA and ERA screening levels. The maximum concentration of 6,300 µg/kg was detected at wetland sample location WSED2 at 7-9 ft deep; north of the Benning Road Bridge. Total PCB concentrations ranged from 0.98 to 6300 µg/kg, with a mean concentration of 340 µg/kg for near-Site sediment samples; 58 samples exhibited concentrations greater than the mean value. Total PCB concentrations for 109 and 150 near-Site samples exceeded the HHRA and ERA screening level, respectively. Total PCBs for Site-specific background locations ranged from <1.0 to 950 µg/kg; the maximum concentration was from sample location SEDBACK15 at 1-3 ft deep. Total PCB concentrations for 16 and 22 Site-specific background samples exceeded the HHRA and ERA screening level, respectively. While Total PCBs were identified throughout the Anacostia River, detections generally decreased with depth at Site-specific background sample locations.

The Preliminary Background Data Evaluation (**Appendix V**) evaluated near-Site PCB (i.e., total Aroclor) sediment concentrations relative to the background surficial sediment total PCB data set collected as part of this RI effort (“Site-specific background”),.

This appendix includes semi-quantitative (pictorial box plots) and semi-quantitative (statistical) analysis. The box plots represent interquartile ranges (IQR) corresponding to quartiles or percentiles of the data (e.g., the 50th percentile represents the median of the data set – 50% of the data at concentrations greater than this value, and 50% of the data are at concentrations less than this value). Additional evaluation will be conducted based on a revised background conditions assessment to be performed in conjunction with the additional field investigation.

According to the Preliminary Background Data Evaluation (**Appendix V**), the IQR and median for the near-Site total PCBs in surficial sediment are greater than the IQR and median for Site-specific background. The mean concentration of PCBs in near-Site sediment is also greater than its Site-specific BTV (250 µg/kg). **Figure 4-12** presents a pictorial representation of near-Site total PCB sediment data at different depths relative to the total PCB BTV. This figure illustrates that the majority of the study area contains total PCB concentrations that are consistent with the sediment concentrations in the Site-specific background data set. However, as depicted in this figure, and also based on the population test and BTV comparison (see Table 7, **Appendix V**), near-Site concentrations of total PCBs in surface sediment are greater than Site-specific background in the Outfall 013 cove area and along portions of the eastern shoreline adjacent to the Site extending up to the Benning Road Bridge. In general, higher PCB concentrations were detected more frequently at shallower depths with the exception of a localized area north of the Benning Road Bridge. Higher concentrations in deeper sediments in this area could have been resulted from the intake dredging performed in 1995. In general, the data indicates that the horizontal and vertical extent of sediment impacts have been adequately characterized. As noted above, these results of the preliminary background evaluation will be updated following additional field investigations.

Pesticides

During the sediment sampling activities, a total of 20 near-Site and 10 background sediment samples were collected and submitted for analysis of pesticide constituents. Based on the analytical data, several pesticide constituents were detected in the near-Site and background sediment samples in excess of the ERA screening levels. No pesticide constituents were detected at concentrations greater than the HHRA screening levels in Near-Site or background samples.

Of the 20 Near-Site samples analyzed for pesticides, 12 constituents (4,4'-DDD; 4,4'-DDE; 4,4'-DDT; Aldrin; cis-chlordane; dieldrin; endosulfan sulfate; endrin; endrin ketone; heptachlor epoxide; methoxychlor; and trans-chlordane) exceeded the ERA screening levels. Of the 10 background samples analyzed for pesticides, 10 constituents (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, cis-chlordane, dieldrin, endrin, endrin ketone, heptachlor epoxide, methoxychlor, and trans-chlordane) exceeded the ERA screening levels.

Most pesticides identified in near-Site samples were also detected at comparable concentrations in background samples. The following pesticide COIs were determined to be COPCs: 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and trans-chlordane. (The selection of COPCs is further explained in Section 6, as part of the human health and ecological risk assessments.) There are no known sources of organochlorine pesticides on the Landside portion of the Study Area. However, a more detailed account of potential historical pesticide storage and use on site will be included in an updated CSM to be prepared in conjunction with an additional round of sampling. The COI pesticides 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and trans-chlordane were widely used historically in urban areas for mosquito and termite control. They are persistent in soils and commonly detected in urban soils and sediments many decades after application.

As per the Preliminary Background Data Evaluation (**Appendix V**), the medians and IQRs 4,4'-DDT in near-Site surface sediments are similar to or less than the Site-specific background medians and IQRs. The medians and ranges for 4,4'-DDE and 4,4'-DDD in near-Site surface sediment are greater than the Site-specific background medians and ranges. Based on the Site-specific BTV comparisons, mean concentrations of 4,4'-DDE and trans-chlordane are below their respective BTVs. However, the mean concentrations of 4,4'-DDD and 4,4'-DDT in near-Site sediment are above their respective Site-specific BTVs.

The findings of the preliminary background evaluation suggest that the levels of some pesticides in surface sediment within the Study Area may be slightly elevated relative to Site-specific background levels. As noted above, these results of the preliminary background evaluation will be updated following additional field investigations.

Dioxins/Furans

During the sediment sampling activities, a total of 20 near-Site and 10 Site-specific background sediment samples were collected and submitted for dioxin/furan analysis. Dioxin/furans in sediment were reported at concentrations greater than the HHRA and ERA screening levels.

Of the 20 near-Site sediment samples analyzed for dioxin/furans, 17 dioxin/furan constituents exceeded the ERA screening levels. TCDD TEQ for human health was identified in 9 Near-Site samples at concentrations greater than the HHRA screening level in sediments. TCDD TEQ for human health concentrations ranged from 0.323 to 707 pg/g, with a mean concentration of 52.6 pg/g for Near-Site sediment samples; 2 samples exhibited concentrations greater than the mean value. The HHRA screening level for TCDD TEQ for human health was exceeded in 9 of the 20 near-Site samples. The maximum concentrations were reported at SED-7F; proximal to Outfall 013.

Of the 20 Site-specific background sediment samples analyzed for dioxin/furan, 2 constituents exceeded the ERA screening levels. No dioxin/furan constituents were detected at concentrations greater than the HHRA screening levels in Site-specific background samples.

According to the Preliminary Background Data Evaluation (**Appendix V**), the medians and ranges for PCDD/DF congeners (1,2,3,4,6,7,8-HpCDD, 1,2,3,4,6,7,8-HpCDF, OCDD, and OCDF) in near-Site surface sediment are greater than the Site-specific background medians and ranges. The findings of the preliminary background evaluation suggest that the levels of PCDD/DF congeners in surface sediment in the Study Area may be slightly elevated relative to Site-specific background. As noted above, these results of the preliminary background evaluation will be updated following the additional field investigation.

4.7 Preliminary PAH Forensic Analysis

A subset of the soil, storm drain, sediment, and groundwater samples were selected for parent and alkylated PAH analysis by the TA-Knoxville method SOP ID-0016 per the approved RI-FS Work Plan and QAPP. Samples for forensic analysis were selected to provide geographic coverage of the site and background area, and to capture information about representative locations for both petrogenic and pyrogenic sources.. The results of the preliminary PAH forensic analyses are presented in **Table 4-12** through **Table 4-17**. As described in this section, although this preliminary forensic analysis indicates that PAHs in site soils and stream sediments are predominantly from combustion related sources (pyrogenic) rather than fuels (petrogenic), additional sampling for an expanded list of alkylated hydrocarbon compound list and biomarker compounds will be conducted in conjunction with the upcoming additional site investigation activities and a revised forensics analysis will be performed using the resulting dataset. The reader, therefore, should note that the results and conclusions discussed in this section are preliminary and should be considered inconclusive pending the performance of the revised forensics analysis. The surficial sediment PAH profile in the river sediments may be generally more pyrogenic than the subsurface sediments, possibly indicating a reduction in petrogenic inputs over time. If confirmed by additional sampling, this predominantly pyrogenic pattern might be consistent with PAHs from urban background sources, such as vehicular exhaust and road runoff that have been reported in other urban rivers and waterways, although a rigorous site-specific PAH background evaluation to confirm this theory was not performed for this analysis. Pending confirmation, the similar distribution of total PAHs detected in upstream background sediments and near-Site sediments could indicate that the Benning facility might not be a significant point source of PAHs in the Anacostia, but part of the background of typical urban runoff, although, again, additional analysis is needed for confirmation.

The SOP ID-0016 method is based on ASTM Method 7363 and EPA 8270, utilizing LRMS and isotope dilution technique to quantify an extended list of 19 parent and 23 alkylated PAHs (defined in QAPP Table 5). It should be noted that this list is non-definitive for delineating more fully the range of PAH impacts potentially attributable to the Site, and will thus be revised in the upcoming sampling phase. This extended analyte list is better suited for forensic source determination than the traditional set of EPA 16 Priority Pollutant PAHs used for site characterization (Boehm, 2006) but this analyte list is not definitive and will be expanded in upcoming sampling phases to the improve the forensic analysis. Per Tables 4 and 5 of the SAP, five surface soil samples, five subsurface soil samples, eight surface sediment samples, seven subsurface sediment samples, two storm drain sediment samples, and four groundwater samples were selected in this preliminary forensics analysis to provide initial working geographic coverage of the site and background locations, and capture samples with the highest Priority Pollutant PAH concentrations in each sample type group, as well as the highest and lowest PAH/TPH ratios. A broader range of samples will be selected when this forensics analysis is revised. An additional soil boring sample (SB30303N) was analyzed due to detected fuel odors during sample collection.

The preliminary forensic analysis is intended to provide a first cut approximation of whether and to what extent past or current conditions at the Site have caused or contributed to contamination of the River. A more in-depth analysis will be conducted pending the additional field sampling event that will more definitively address this question. For this preliminary analysis, the forensic techniques employed include both the analysis of patterns of relative abundance in the extended PAH results and the geographic distribution of total PAH abundance comparing site to background locations.

PAHs are ubiquitous environmental contaminants that that derive primarily either from fossil fuel sources such as oil or coal (petrogenic sources) or combustion and pyrolysis sources such as fuel burning or creosote/coal tar (pyrogenic sources). The EPA Priority Pollutant PAHs are 16 parent PAHs with 2 to 6 rings and no substituent groups attached to the rings. The alkylated PAHs have the parent PAH ring structure with alkyl hydrocarbon groups attached. The groups of alkylated PAHs that share a common number of carbon atoms in the alkyl substituents are represented by a homolog group, such as C3-phenanthrene/anthracene which includes many isomers or arrangements of the 3 carbon atoms on the phenanthrene or anthracene 3 ring structure. Parent and alkylated PAH homologs can be grouped into petrogenic or pyrogenic classifications according to the most probable source (Stout, 2004). The petrogenic and pyrogenic classes are not absolute, because some PAHs can come from either source. The target analyte PAHs are grouped by parent or alkylated, number of rings, and pyrogenic or petrogenic classification in **Table 4-18**. The compound list for the revised hydrocarbon forensics to be completed following the upcoming sampling event will be revised as appropriate to include additional analyte groups, such as refined product markers (n-alkanes, isoprenoids, paraffins, and unresolved saturated hydrocarbons), additional parent and alkylated and polycyclic aromatic hydrocarbons (PAH), and geochemical biomarkers (terpanes, sesquiterpanes, steranes, diterpanes, triterpanes, and triamromatic steranes).

The pattern of relative abundance of PAHs in a sample provides a fingerprint that yields preliminary clues about the PAH origins. The individual PAHs and homolog groups are normalized by dividing each concentration by the total concentration to create a pattern that is concentration independent and conveys only relative abundance. Profiles of these patterns are provided for all project soil samples in **Appendix W**, **Figure W-1**, sediment samples in **Figure W-2**, and groundwater samples in **Figure W-3**. Note the target compounds 2,6-dimethylnaphthalene and 2,3,5-trimethylnaphthalene are subsumed by C2-naphthalene and C-3-naphthalene groups and are not included in the profiles. PAHs are profiled left to right in the sort order of **Table 4-18**. Pyrogenic PAHs are colored red, mixed pyrogenic/petrogenic are colored purple, and petrogenic PAHs are colored blue. The PAH perylene, here colored green, can be derived from pyrogenic sources in surficial soils and sediment, but is likely to be derived from biogenic sources in deeper sediments (Slater, 2013).

The typical PAH fingerprint from petrogenic sources like crude oil and fuels is dominated by low molecular weight alkyl PAHs in the 2 to 3 ring range, whereas the pyrogenic source pattern from fuel combustion and other high temperature sources in urban runoff is dominated by high molecular weight parent PAHs in the 4 to 6 ring range (Boehm, 2006). The petrogenic alkyl pattern typically exhibits an arch of homologs such that the Parent<C1<C2>C3>C4. The pyrogenic alkyl pattern generally declines with increasing alkyl carbon number, sloping away from the parent PAH such that Parent>C1>C2>C3>C4.

On a preliminary basis, a review of the PAH patterns in **Figure W-1** and **Figure W-2** suggests that the prevailing pattern is pyrogenic in almost all soil and sediment samples, with 4-6 ring parent PAHs and phenanthrene dominant and only minor contribution from alkyl PAH homologs. Examples of this strongly pyrogenic signature are apparent in the site soils SUS2400N, SUS1900N, SUS2200N, and DPS1910N, and in the storm drain sediment SDR013N, as well as the site sediment SED10C00N, and background upstream river sediments SEDBACK400N, and SEDBACK600N. The degree of pyrogenic PAH contribution to these samples is generally over 80%, and all but 4 samples are above 50% pyrogenic, as show in **Table 4-19** where the relative contribution of pyrogenic and petrogenic PAHs is calculated for all samples in the forensic sample set. The dominant pyrogenic signature was confirmed by examination of selected DRO and SVOC chromatograms for these samples, where parent PAHs are the major peaks and there is little evidence of an unresolved complex mixture (UCM) from petroleum hydrocarbons. The above noted conclusions are preliminary and in the revised forensics analysis, a multiple lines of evidence approach will be implemented to more accurately identify sources of contaminants (background, historical and on-going) to the Anacostia River. Implicit in this revised analysis will be better development of a more site-specific background PAH dataset and an expanded forensic analyte list.

Based on the limited suite of PAH compounds available in this initial analysis, sample patterns exhibiting a strongly petrogenic pattern are much less common in the forensic sample set. . Only two samples, site soils SBS0303N and DPS3903N, out of 30 samples analyzed have an estimated petrogenic PAH contribution exceeding 80%. SBS0303N was the site soil selected due to the strong petroleum product odor noticed during sample collection. The PAH graph is dominated by the 2 and 3 ring alkyl PAHs, such as the alkyl naphthalenes where N0<C1<C2<C3<C4, alkyl phenanthrene/anthracenes where P0<C1<C2>C3>C4, and alkyl fluorenes where F0<C1<C2>C3. This petrogenic signature is confirmed by DRO chromatogram which displays a bimodal UCM with one maximum near n-C20 and another near n-C30. The UCM pattern and lack of prominent n-alkanes indicates a possible mineral oil or highly weathered midrange petroleum distillate mixed with lubricating oil. The DRO pattern does not appear to be consistent with fresh fuel oil, however the GC-FID conditions used for DRO analysis are not ideal for forensic determination of source petroleum product. The DPS3903N PAH pattern is similar to SBS0303N but the parent and alkyl naphthalene ratios are different, however the DRO pattern is dominated by a trimodal UCM indicating multiple weathered petroleum derived oils may be present. This sample is near the oil tanks in target area 13, and the patterns may be attributable to residual fuel oils #2 and #4 in subsurface soils. No fuel oil in tanks or lines was available at the site for fingerprinting. All of the conclusions discussed above will be reassessed in the revised forensics analysis which will include a comparison of sampling results to reference analyses of fuel oil #2 and #4 and an evaluation of external processes such as weathering effects that could impact the individual PAH distributions. Information from the revised CSM that will be prepared for the site will help inform this analysis.

Among the sediment samples reviewed in this preliminary analysis, only SED6C03N and SED10C07N have a petrogenic PAH abundance exceeding 50%. The PAH pattern in these deeper and presumably older site sediment samples appears to be an equal mix of petrogenic alkyl PAH ratios and the more common pyrogenic pattern. The surface sediment sample at location 10, SED10C00N, is much more pyrogenic (84%). In general the surface sediment samples in the site and background groups appear to be more pyrogenic in nature than deeper sediments, suggesting a reduced input from petrogenic sources over time. This general PAH profile with depth was observed in previous studies (Velinsky, 2011). An exception to this rule is location 7 where the surface sediment is slightly more petrogenic than the 1 foot depth sample. The SVOC analysis total ion chromatographic patterns in these samples (DRO was not a sediment sample analyte) indicate prominent bimodal UCMs in both samples, suggesting multiple weathered petroleum derived oils may be present.

Other river sediment samples exhibit a continuum of pyrogenic PAH content of 50 to 80% with a proportional range of petrogenic PAH content from near 50 to less than 20%. The mean of surface sediment sample ratios is 72% pyrogenic and 26% petrogenic. The unusually low ratios of fluoranthene/pyrene and phenanthrene/anthracene in upstream samples SEDBACK1103N, SEDBACK503N, and the in-channel site sediment SED603N, combined with petrogenic alkylnapthalene, alkylfluorene, alkylphenanthrene, and alkyldibenzothiophene signatures suggest diverse sources of mixed pyrogenic/petrogenic inputs from sources upstream. The unusually high relative abundance of perylene in sample SEDBACK1103N indicates a biogenic, rather than pyrogenic origin. The **Figure 4-16** map presents pie charts for site sediments, where the total parent priority pollutant 4-6 ring PAHs, generally associated with pyrogenic sources, are indicated by the major blue wedge, and the total 2-3 ring parent PAHs, which can indicated petrogenic sources, are indicated by the minor yellow wedge. This pattern confirms the overall pyrogenic signature of PAHs in the river sediments. The **Figure 4-17** map displays the same 4-6 ring PAH and 2-3 ring PAH relative composition for site soils and site sediments. .

The relative distribution of pyrogenic and petrogenic contributions in surface sediments does not display any obvious geographic pattern between upstream and downstream background locations when compared to the site sediment samples in the river or storm drains. However, this preliminary gross level separation of PAHs is a first-cut type analysis and will be refined accordingly in the upcoming analysis. The revised CSM to be prepared in conjunction with the upcoming phase of work will more completely characterize the nature and extent of historical releases from the Pepco facility to the environment (i.e., soil and sediments). The overall pattern is remarkably consistent with the urban background pattern reported in other urban waterways such the Elizabeth River, Eagle Harbor, Thea Foss, and Boston Harbor (Stout, 2004). Mobile PAH sources such as vehicular exhaust are the major contributor to PAH releases in the urban atmosphere and atmospheric deposition is the dominant source of PAHs in urban soil and surface water (ATSDR, 1995). This suggests a diffuse, nonpoint, urban environment source might be responsible for the PAHs, and in particular that combustion derived particulate matter from vehicular exhaust in road runoff might be the primary source of PAHs in the Upper and Middle Anacostia River near the Benning site. This conclusion was reached by Hwang and Foster in a 2005 study of stormwater runoff in the same area of the Anacostia. PAH pattern analysis indicated vehicular exhaust was the dominant source of pyrogenic PAHs, not wood or coal combustion, and that the petrogenic inputs were attributable to leaking crankcase oil and unburned fuel from tailpipes, rather than historical oil spills in the area (Hwang, 2006). Previous studies also concluded that the PAH inputs to the river sediment were diffuse and related to street runoff (Wade, 1994). However, the aforementioned revised forensics will focus on more accurately assessing the significance of these sources relative to potential Site inputs of PAHs to river sediments. A comparative analysis (graphical and statistical) is needed to compare Pepco chemical profile background data to chemical profile data from these published studies of urban background PAHs and such an analysis has not been performed in this preliminary forensic analysis. The revised forensics analysis will evaluate the degree to which PAH data from the Pepco investigation areas is chemically and statistically similar to Anacostia River site-specific background/reference area and/or urban background as published in these studies from other sites

The distribution of total detected PP PAHs in all site and background soil and sediment samples as box and whisker plots is presented in **Figure 4-18a**. The PAH sum results are grouped by matrix and stream reach allowing comparison of site surface soils, site subsurface soils, site storm drain sediments, site river sediments (all depths),upstream background sediments (all depths), and downstream background sediments (all depths). Frequency of detection (FOD) information is presented for each group as detected : total values.   The gray box includes all results between the 25th and 75th percentiles, the line inside the box is the median value, the upper whisker represents the largest result less than or equal to the 75th percentile plus 1.5 times the interquartile range, and the lower whisker represents the smallest result greater than or equal to the 25th percentile minus 1.5 times the interquartile range. Results outside the whisker limits are represented by dots. **Figure 4-18b** presents the same dataset with outside values removed to better illustrate relationships between the bulk of the result values in the boxes. The similar distributions of PAHs in site soils, site river sediments and downstream background sediments indicate that Site storm drain sediments exhibit higher concentrations than Site surface soils, Site direct push subsurface soils, and background downstream river sediments. The Benning site may not be a major source of ongoing PAH contamination in the Anacostia River. Additional forensic data from the next phase of sampling and analysis will be used to confirm or revise this preliminary conclusion.

The site storm drain sediments appear to be biased high relative to other groups, but the sample number was very low. One source for the higher levels of pyrogenic PAHs in the storm drains might be runoff from weathered parking lot areas treated with coal tar based seal coat, mixed with vehicle exhaust soot and crankcase oil. Based on the limited list of PAHs used in this analysis, the PAH profiles for storm drain sediments subjected to parent and alkylated PAH analysis are extremely pyrogenic at the 013 outfall (SDR013N) and near Building #56 which drains the southeastern parking lots (SEDPEPR4N). The profile of sediment at the 101 outfall (SDR101N), which drains the western edge of the site including parking areas behind the Generating Station, indicates a mix of pyrogenic and petrogenic inputs (48% petrogenic, 51% pyrogenic), which, among other potential site-related sources, might indicate crankcase oil and exhaust soot or asphalt sealant as sources. Previous research has demonstrated particles in runoff from coal tar based asphalt sealants is a major source of PAHs in urban waterways (Mahler, 2005; Van Metre, 2010). The particulate contribution from Benning storm drain runoff in particular however does not appear to have elevated near site sediments significantly above background sediment values based on **Figure 4-18b**. Trapping features within the storm drain structure may be limiting discharge of the PAH contaminated sediments into the river.

The map of total PAH concentrations in Anacostia River surficial sediment presented in **Figure 4-10** also confirms that in-channel site sediments are not substantially higher than adjacent upstream and downstream areas between background location 2 and background location 15. However, given that many samples external to the study area are from the NOAA database and are, therefore, reflective of PAH concentrations from one or more decades ago, (e.g., from times when multiple independent studies indicate that higher contaminant concentrations characterized the entire river), this figure suggests that Site PAH concentrations are comparable to previous times when PAH contamination levels were more elevated in the entire river. The central question of how Site PAH concentrations compare to contemporaneous PAH background concentrations in river sediments will be further addressed in the revised forensic analysis. Results from the NOAA database at the confluence of Hickey Run with the Anacostia immediately upstream of the Benning site have been identified as a hotspot which may have contributed TPH and PAHs to the Benning site sediments, but this location was not sampled as part of this RI/FS study (EPA, 2005). **Figure 4-9** presents total PAH concentrations in site sediments by depth interval, which at multiple depths (including some greater than seven feet), do not indicate a pattern of substantially increasing PAH concentrations near the outfalls, and a generally decreasing concentration with depth. The revised CSM that will be prepared in conjunction with the upcoming additional sampling event will help to better understand potential Site contributions to the observed PAH distribution shown on Figure 4-10.

PAH profiles in the groundwater samples selected for forensic analysis are generally dominated by 2-3 ring PAHs because these PAHs are much more soluble in groundwater than the 4-6 ring PAHs. PAH concentrations are very low, ranging from < 1 ng/L to slightly more than 1 µg/L, but generally in the single to double digit ng/L range. Determining source patterns of pyrogenic and petrogenic PAHs in water at these low levels is difficult due to the bias introduced by relative solubility. Low levels of colloidal particles in the water can also support PAHs at concentrations well above the truly dissolved concentrations. The pattern of naphthalene and C1 to C4 alkyl naphthalenes in samples MW12AN2 and MW09AN2 suggests gasoline or vehicular exhaust as a potential source. Given the position of these wells near Benning Road and the amount of pavement cover in this area storm water road runoff could contribute to local groundwater. Another possible groundwater source is site fill soils or former Site UST cleanup residual contamination in the subsurface. The very low levels of PAHs detected in groundwater, especially at MW02 nearest the river, may indicate that groundwater transport off site is not a significant potential source of contamination to the Anacostia River.

In conclusion, this preliminary forensic analysis suggests that PAHs in site soils and stream sediments may be predominantly from combustion related sources (pyrogenic) rather than fuels (petrogenic), although as noted, this conclusion is based on a limited list of PAHs and a limited site-specific background dataset. The surficial sediment PAH profile in the river sediments may be generally more pyrogenic than the subsurface sediments, indicating a reduction in petrogenic inputs over time. This predominantly pyrogenic pattern is consistent with PAHs from urban background sources, such as vehicular exhaust and road runoff that have been reported in other urban rivers and waterways. The similar distribution of total PAHs detected in upstream background sediments and near site sediments indicates that the Benning facility exhibits PAH concentrations comparable to historic levels of PAHs in the Anacostia River, but additional background data and further forensic analyses are needed to assess the relative contribution of site and non-point urban runoff sources.

4.8 PCB Forensic Analysis

A subset of the soil, sediment, and groundwater samples were selected for PCB congener and homolog group analysis by EPA Method 1668C at the TA-Knoxville laboratory per the approved RI-FS Work Plan and QAPP. Samples for forensic analysis were selected to provide geographic coverage of the site and background area, and to capture information about representative locations dominated by a single Aroclor as well as representative Aroclor mixtures. The results of the PCB forensic analyses are presented in **Table 4-12** through **Table 4-17**.

This preliminary PCB forensics analysis relies on PCB congener pattern analysis, the results of which generally confirm the qualitative Aroclor identifications. However, only a limited number of samples were analyzed for PCB congeners; additional congener analyses will be performed for the revised forensics analyses to be conducted in conjunction with the upcoming additional sampling event. Results presented in this section are preliminary and may be revised pending the results of the upcoming additional, expanded sampling event. This forensic analysis suggests that a range of similar PCB patterns is present in all river sediment samples, both near-Site and in upstream background locations. The river sediment pattern is attributable to mixtures of Aroclor 1248 and Aroclor 1260 in varying ratios. This fact combined with the total PCB distribution analysis indicates significant contribution to the in-channel river sediment PCBs by off-site upstream sources. However, on-Site PCB congener profiles confirm positive detections of Aroclor 1242, Aroclor 1254, and Aroclor 1260 in soil samples collected on-Site thus suggesting possible Site contributions to river sediments. Site surface and subsurface soils generally exhibited different patterns of Aroclor type (dominated by Aroclors 1254, 1260, and 1242 in surficial soils) and congener relative abundance that were distinct from the river sediments. This suggests that site surface runoff might not be the principal source of PCBs in the site adjacent river sediments, however it does not rule out the site landside as a source of PCBs from historical releases via the storm drains. Elevated concentrations of PCBs near the 101 and 013 Outfalls in particular may indicate localized historical contribution to the river sediment PCB by storm water runoff, however the near absence of detectable PCBs in the current site storm water indicate this is not a significant ongoing source to the river. On site groundwater PCB congener patterns were generally consistent with local known sources such as the cooling tower-adjacent soils and verified the Aroclor analysis qualitatively and quantitatively, however total PCBs in groundwater are so low and the potential for migration of the more hydrophobic congeners through soil via groundwater is so limited that groundwater transport from the site may not be a significant source of input to the river PCB load.

EPA Method 1668C, a High Resolution Gas Chromatography/High Resolution Mass Spectrometry (HRGC/HRMS) method, was used to quantify all 209 of the possible PCB congeners. Some congeners coelute under the EPA recommended column conditions, resulting in 162 discrete peaks which can be subjected to pattern analysis. This large analyte list provides more power to discriminate between PCB sources than the conventional Aroclor analysis by EPA Method 8082, a Gas Chromatography/ Electron Capture Detector method (GC/ECD), which relies on a pattern of only 5 peaks or less per Aroclor for qualitative identification and quantitation. When the pattern match with reference Aroclors is near perfect and a single Aroclor is detected, EPA Method 8082 can provide very accurate data on PCB concentrations and identification. This is common in soils where the PCBs are strongly sorbed to particles and the Aroclor pattern is unaltered by weathering. Aroclors with higher chlorine content such as Aroclor 1254 or Aroclor 1260 can persist almost unchanged for decades in oxic soils. However, when the Aroclors are badly weathered by volatilization and water washing, or subjected to reductive dechlorination in anoxic sediments, the original Aroclor peak pattern can be altered enough to compromise both the qualitative identification of Aroclor type and the quantitation of total PCB concentrations by GC/ECD analysis. The ECD detector is also susceptible to interferences from other non-PCB organic compounds which contain electronegative atoms, such as organochlorine pesticides like DDT, that survive extract cleanups. The HRMS analytical finish of EPA Method 1668C is both more sensitive and specific than GC/ECD, eliminating most interferences. The isotope dilution technique of EPA 1668 also adjusts the results for extraction inefficiency and losses during cleanup, providing a more accurate quantification of each PCB congener, regardless of the PCB pattern, and permitting the quantitation of complex and degraded Aroclor mixtures as well as non-Aroclor PCB sources (Johnson, 2006).

In general accordance with Tables 4 and 5 of the SAP, a total of seven site surface soils, three site subsurface soils, six surface sediments, nine subsurface sediments, two storm drain sediments, and five groundwater samples were selected to provide adequate geographic coverage of the site and background locations, plus capture samples with representative Aroclor types identified by the EPA 8082 analyses. Samples with highest concentrations of single Aroclors were selected as possible end members in the pattern distribution. Although this sample subset is SAP compliant, an assessment of the appropriateness of this sample subset for achieving project objectives and clearer documentation of the rationale used for its selection will be provided in conjunction with the revised forensics analysis. The intent of the current preliminary forensic sample result analysis was to determine, on a first approximation basis, potential sources of PCBs in site and background locations by analyzing both pattern and concentration of PCBs, as well as verifying the qualitative and quantitative accuracy of the primary Aroclor based analysis by EPA 8082, which was used for characterization of the nature and extent of PCBs in the RI/FS. This forensic analysis is also intended to provide preliminary information regarding conditions at the Site may have caused or contributed to contamination of the River. A revised CSM and additional PCB congener sampling will be performed to further assess whether and to what extent past or current conditions at the Site have impacted the River.

PCBs, like PAHs, are ubiquitous environmental contaminants, spread worldwide in air, water, and soil. Unlike PAHs, PCBs have no known natural sources and are strictly anthropogenic industrial products. PCBs were commercially first produced in 1929, and the bulk of the industrial production in North America was by Monsanto under the trade name ‘Aroclor’. This trade name was followed by a number where the last two digits indicate the approximate percent chlorine in the complex mixture, e.g. Aroclor 1260 which is 60 wt % chlorine. Each Aroclor is composed of a complex mixture of more than 100 individual congeners. Variations in congener composition by production lot are generally very small, and easily dwarfed by the effects of weathering, so distinguishing between different sources for a specific Aroclor after release in the environment is extremely difficult. Commercial PCB mixtures were used in a wide variety of applications including dielectric fluids in transformers and capacitors, heat transfer fluids, hydraulic fluids, lubricating oils and waxes, as well as additives in paints, carbonless copy paper, caulk sealants, adhesives, and plastics (Erickson,2011). Although a more detailed accounting will be provided in the revised CSM, currently known uses of PCBs at the Pepco Benning site which resulted in releases to the environment were dielectric fluids from transformers and caulking plasticizer in the concrete cooling tower basins.

The pattern of relative abundance of PCB congeners in field samples can be compared to compositional information from a complete analysis of reference Aroclor lots (Frame, 1996). Normalized profiles for the field samples are compared to reference Aroclor patterns, selected for the particular Aroclors identified in the original EPA 8082 analysis results, in **Appendix X**. **Figure X-1** for soils, **Figure X-2** for sediments, and **Figure X-3** for groundwater.

The visual comparison of congener profiles has been supplemented by the numeric similarity metric cosine theta (Johnson, 2006). An updated version of this analysis may be included in the revised forensic analysis. Cosine theta similarity compares the patterns as multidimensional vectors, where the angle between the vectors is a function of the similarity of the patterns. A perfect match between coincident vectors yields a cosine of 1, and if the patterns have no matches (90 degrees apart) then then the cosine will be 0. Cosine theta values were calculated using Stata (rev IC 11) comparing all sample patterns with each other and with the reference Aroclor patterns from the Frame dataset. These values are presented in **Table 4-20**, where cell colors correspond to the strength of the match, e.g. dark blue for cos theta 0.9 to 1.0, medium blue for cos theta 0.8 to 0.9, and light blue for cos theta 0.7 to 0.8.

The congener profile in surface soil sample SUS0500N displays an excellent match with Aroclor 1254 lot G for all congeners from PCB-16 to PCB-190 (cos theta = 0.993). This single Aroclor was identified in the Method 8082 results for this sample. Aroclor 1254 was one of the few Aroclors that was manufactured by two different processes that created very different congener patterns. The Frame lot G type is the more common and less toxic version. All samples identified as Aroclor 1254 in the project Method 8082 data have congener patterns in the Method 1668 more closely resembling this 'Type 1' variant. The late production Aroclor 1254 or 'Type II' variant (Lot A in the Frame dataset) was generated by a two-step process that produced more of the toxic dioxin-like congeners (Johnson, 2006; Johnson, 2008). Sample SUS0500N has cos theta values indicating excellent matches to soil samples SUS0800N and DPS0515N, which were also identified as only Aroclor 1254 in the Method 8082 analyses. These samples are all located in the same site area as the cooling towers, where caulk and construction debris in fill material are a possible source of Aroclor 1254. Again, it should be emphasized that these results are preliminary.

The congener profile in surface soil sample SUS0600N displays an excellent match with Aroclor 1260 (cos theta = 0.966). This single Aroclor was identified in the Method 8082 results for this sample. Cos theta values indicate excellent matches with soil sample SUS1200N and sediment sample SDR013 as well. Sample SUS1200N is located near the salvage yard cleanup area by Building #75, where previous analyses identified Aroclor 1260 (Pepco, 2003). Aroclor 1260 has also previously been identified in storm drain sediments, such as outfall 013 where SDR013 was collected (EPA,1997).

The congener profile in surface sample SUS0800N displays a strong match to Aroclor 1254 (cos theta = 0.967) and a much weaker match to Aroclor 1260 (cos theta = 0.592). This sample was reported as 64% Aroclor 1254 and 36% Aroclor 1260 in the Method 8082 results, however the relative contribution of Aroclor 1260 appears to be much lower based on the Method 1668 analysis. Some specific congeners such as PCBs 195, 196, 201, 202, 203, and 205 are attributable to Aroclor 1260, but not Aroclor 1254. Ratios of the later peaks imply less than 10% contribution from Aroclor 1260. The difference between the Method 8082 and 1668 results could be due to sample inhomogeneity, or the intrinsic difficulty of quantifying overlapping Aroclors, like 1254 and 1260, by Method 8082.

The congener profile of surface sample SUS1000N appears to be a mix of roughly equal amounts of Aroclor 1248 and Aroclor 1260. The Method 8082 results indicated 36% 1248 and 64% 1260. The cos theta values of 0.780 for Aroclor 1248 and 0.612 indicate this metric is strongly affected by overlapping patterns that share features. Even though the pattern match to any single Aroclor is not strong, the cos theta values above 0.9 for samples DPS4403N, SED1C07N, SED2.5B05N, SED2A00N, SED6.5E01N, SED7.5E00N, SED9.5B00N, SED9.5B03N, SEDBACK1101N, SEDBACK500N, and SEDBACK600N indicate strong similarities of congener pattern in all these sample with SUS1000N. When a reference Aroclor mixture using 50% Aroclor 1248 and 50% Aroclor 1260 (identified as 50-50 Mix at the bottom of **Table 4-20**) compared to SUS1000N the cosine theta value increases to >0.9, corroborating the qualitative assignment in the Method 8082 analysis.

The congener profile of surface sample SUS1200N indicates a good match with Aroclor 1260 in the PCB-100/115 to PCB-203 range (averaging >50% based on relative peak height), and a poorer match with Aroclor 1242 in the PCB-15 to PCB-118 range. The Method 8082 analysis indicated 62% Aroclor 1260 and 38% Aroclor 1242. The cosine theta values indicate a good match with Aroclor 1260 (0.890), but a very poor match with Aroclor 1242 (0.287). Selective congener loss due to weathering may explain the poor match with the lighter Aroclor 1242 which is more susceptible to weathering due to the lower homolog distribution of its constituent congeners. The SUS1200N pattern is a close match with samples DPS4403N, SDR013N, and SED7.5D03N based on cos theta values > 0.9.

The congener profile for surface sample SUS2000N indicates a good match with Aroclor 1248 and Aroclor 1260 in roughly an 85% and 15% mix, similar to the 80% Aroclor 1242 and 20% Aroclor 1260 of the Method 8082 results. Aroclor 1242 and 1248 are difficult to distinguish because they contain the same congeners with shifted relative abundance. Aroclor 1242 contains a greater relative abundance of the PCB-4 to PCB-22, but these di to trichlorobiphenyl congeners are susceptible to loss by evaporation and water washing. Weathering of Aroclor 1242 can produce a pattern matching Aroclor 1248 (Johnson,2006). The cos theta value of 0.925 confirms the good match with Aroclor 1248, however the low relative abundance of congeners in the Aroclor 1260 range produces a poor fit for 1260 (cos theta = 0.240). The cosine theta value increases to 0.928 when compared to a reference Aroclor mix of 74% Aroclor 1248 and 26% Aroclor 1260 (identified as ‘74-26 Mix’ at the bottom of **Table 4-20**).

The congener profile for surface sample SUS2100N is almost identical to SUS2000N, and the cos theta value of 0.952 confirms the visual similarity. The mixture of Aroclor 1248 and Aroclor 1260 patterns was interpreted as Aroclor 1242 and Aroclor 1260 by the Method 8082 analysis as well, with a relative abundance of 88% 1242 and 11% 1260. When compared to the reference Aroclor mixture of 74% Aroclor 1248 and 26% Aroclor the cosine theta value is 0.917, confirming the pattern match.

The congener profile for subsurface sample DPS1510N displays as very good match with Aroclor 1260 in the PCB-90/101/113 to PCB-209 range. Cosine theta of 0.929 confirms the match for Aroclor 1260, however the cos theta value for Aroclor 1248 (0.483) is reduced by overlap of congeners in the PCB-82 to

PCB-118 range from Aroclor 1260. In the PCB-8 to PCB-77 range where overlap in minimal, the relative abundance of sample and reference peaks indicates a roughly 20-30% contribution from Aroclor 1248 with a good relative graphical match for most congeners. This corroborates the Method 8082 analyses which reported 38% Aroclor 1248 and 62% Aroclor 1260. Cosine theta values of >0.9 indicate a strong pattern match between DPS1510N and samples DPS4403N, SDR013N, SDRPEPR4N, SED7.5D03N, SED7.5E00N, SEDBACK1100N, SEDBACK1101N, SEDBACK401N, and SEDBACK503N. All of these samples in the qualitatively identified in the Method 8082 results as containing Aroclor 1248 and Aroclor 1260 in varying ratios, except for SDRPEPR4N which was reported to contain Aroclors 1254 and 1260.

The congener profile of subsurface soil DPS4403N indicates roughly equal contribution from Aroclor 1248 and Aroclor 1260, which matches the Method 8082 results of 48% Aroclor 1248 and 52% Aroclor 1260. The cosine theta value of 0.953 for the 50:50 mix of Aroclors1248+1260 confirms the Method 8082 analysis qualitatively and quantitatively.

The congener profiles of the storm drain sediments SDR013N and SDRPEPR4N are both dominated by Aroclor 1260, but the additional minor Aroclor in SDRPEPR4N does more closely resemble Aroclor 1254 in the PCB-82 to PCB-158 range. Cosine theta values are high for Aroclor 1260 in both samples (0.981 and 0.913, respectively), but <0.6 for Aroclors 1248 and 1254. Method 8082 results also indicated Aroclor 1260 was the dominant mixture, with 48% Aroclor 1248 in SDR013N and 28% Aroclor 1254 in SDRPEPR4N.

Site sediments generally have congener profiles that more strongly resemble each other and the background sediments than any particular single reference Aroclor, as indicated by cosine theta values of > 0.9 for when compared to each other, but <0.9 when compared to pure reference Aroclors. Method 8082 results indicated >50% contribution from Aroclor 1248 in most site and upstream background sediment samples, with the remainder attributed to Aroclor 1260. Mixes of the reference Aroclor patterns were created based on the distribution of Aroclors from the EPA 8082 analysis in the sediment samples as a group, where the mean ratio was 65% Aroclor 1248 and 35% Aroclor 1260. Most samples were within 5% of this ratio, and those outside this range above and below had mean values 74% Aroclor 1248/ 26% Aroclor 1260, and 50%Aroclor1248/50%Aroclor 1260, respectively. Cosine theta values for these mixtures are provided on the last three rows of **Table 4-20**. Values > 0.9 indicate very good matches for one or more of these mixes with nearly all site sediment samples (SED1C07N, SED2.5B05N, SED2A00N, SED6.5E01N, SED7.5D03N, SED7.5D03N, SED7.5E00N, SED9.5B00N, and SED9.5B00N) as well as the upstream background samples (SEDBACK1100N, SEDBACK1101N, SEDBACK401N, SEDBACK500N, and SEDBACK600N). The exceptions to this rule are sample SEDBACK503N, where the Aroclor 1248 contribution appears to be lower than 50%, and the deep mudflat sediment WSED207N. The increased abundance of PCB-52, PCB-26/29, PCB-25, and PCB-6 in the WSED207N may indicate some reductive dechlorination in this deeper sediment. The resulting increases in lower molecular weight congeners decreases the cosine theta match with reference Aroclors and Aroclor mixes.

Overlap of the Aroclor 1248 and Aroclor 1260 pattern in PCB-90/101/113 to PCB-158 congener range, could be interpreted as the presence of Aroclor 1254 in the mixture, although this Aroclor assignment was not qualitatively reported by the Method 8082 analysis. Overall, on the basis of the sample subset used in the comparison which was somewhat limited, the Aroclor assignments from the Method 8082 analyses might confirm the Method 1668 congener data pattern analysis, which suggests that the qualitative and relative Aroclor data from Method 8082 can be used for preliminary first cut forensic purposes. These conclusions will be subject to follow-up confirmatory analyses.

No clear pattern emerges in the sediment sample profiles with respect to sample depth or distance from the site. The ratios of Aroclor 1248 and Aroclor 1260 reported in the Method 8082 results and indicated in the Method 1668 congener profiles appear to vary randomly among the range of ratios in site and background sediment samples. Generally good pattern matches in the lowest homolog groups with reference Aroclors indicates that reductive dechlorination of PCBs has not produced a significant accumulation of mono, di and trichlorobiphenyl congeners in the river sediments, with the possible exception of the deep mudflat sample WSED207N. On a preliminary basis, cosine theta values might indicate the river sediment patterns resemble each other more than most landside site soil patterns. Site soils with the closest pattern resemblance to the river sediments are SUS1000N, DPS1510N, and DPS4403N, but, based on the samples selected for this analysis, landside site soils might not match the in-channel river sediment profile.

Another perspective on the pattern analysis of the EPA 1668 datasets is provided by Principal Component Analysis. Principal component analysis (PCA) was used to describe the variation in PCB congener concentrations in terms of new variables (principal components) that are uncorrelated with each other. These new variables reduce the dimensionality of the complex dataset and provide a way to plot the relationships of sample patterns. It should be noted that the results of this PCA are sensitive to the subset of samples selected for PCB congener analyses. As noted previously, a potentially new and expanded subset will be provided in the revised forensics analysis. The results discussed below are preliminary and will be subject to modification pending the results of the upcoming additional sampling event. The first principal component is the sum of original concentrations with congener-specific weights that describes the most variability across samples. The second principal component is the sum of original normalized concentrations with a different set of congener-specific weights that describes as much as possible of the remaining variability, and so on. For the purposes of PCA, data were arranged in a matrix with each column representing a different PCB congener and each row representing a different sample. PCB congener concentrations were normalized to total PCBs and non-detect values were assigned a value of zero. The first and second principal components identified during the analysis account for 50.4% and 31.0% of the variability across samples. **Figure 4-21** shows the grouping of samples in relation to the first two principal components. On the figure the first principal component and second principal component are on the X and Y axes, respectively. Reference Aroclors and reference mixes are identified with X's. Site surface soils are purple diamonds, site subsurface soils are red triangles, and storm drain sediments are dark blue squares. Site sediments are solid blank dots and background sediments are open dots. Samples with patterns identified as strongly related to Aroclor 1254 above, i.e. SUS0500N, SUS0800N, and DPS0515N, are grouped together in the upper part of the graph. The sediments with patterns identified as mixtures of Aroclor 1260 and Aroclor 1248 above appear on an arc between the end members of reference Aroclor 1248 (a and g lots) on the left and reference Aroclor 1260 on the lower left, with the Aroclor1248+1260 mixes in between and slightly below the arc. The similarity of the storm drain patterns to Aroclor 1260 is confirmed, as is the similarity of subsurface soils DPS1510N and DPS4403N to the river sediments. Surface soils SUS200N, SUS2100N, SUS1200N, and SUS0600N appear to be more closely related to the reference Aroclor 1248 and Aroclor 1260 patterns, than to the river sediments as a group. The proximity of SUS1000N and SED6.5E01N is an exception to this rule. Aroclors which were *not* identified in the Method 8082 or 1668 results such as Aroclors 1016, 1232, 1221, and 1262 are isolated in the lower part of the plot away from the samples. Overall this PCA score display confirms the preliminary visual pattern analysis of Method 1668 congener results and the preliminary qualitative Aroclor identifications by Method 8082.

Previous reports and research have identified possible upstream sources for PCBs in the Anacostia. Results from the upstream sediment and soil analyses in the Kenilworth Park North Landfill Remedial Investigation indicated the presence of Aroclor 1248, Aroclor 1254, and Aroclor 1260 in off-site sediments and Aroclors 1254 and 1260 in landside site soils (NPS, 2007). NOAA data in the upstream area indicates the presence of Aroclor 1254 and Aroclor 1260 in the marsh area near the river, although much of the NOAA dataset reflects historical concentration conditions that may not accurately reflect current conditions. Recent reports using freshwater clams as biomonitors have indicated significant upstream PCB sources in the Northwest Branch, Northeast Branch, and Lower Beaverdam Creek tributaries to the Anacostia (Phelps,2005; Phelps, 2008). Lower Beaverdam Creek has been implicated as the dominant source of upstream PCB contaminated sediments (Hwang,2008).

Figure 4-13, which maps total PCB concentrations from the 2013-2014 RI investigation as well as the NOAA database, indicates similar PCB concentrations in the in-channel surficial sediments from the confluence of the West and East branches upstream of the Benning site down to the Pope branch well downstream. As was noted for the comparison of Site PAH concentrations to the NOAA data, this comparison suggests that Site conditions are comparable to historical river-wide conditions characterized by more elevated PCB concentrations, since the NOAA dataset is dominated by datasets collected one or two decades ago. Localized areas of increased PCB concentrations near the site 013 and 010 outfalls are indicated in **Figure 4-13** and detailed in the **Figure 4-11** site sediment concentration map. **Figure 4-20** shows the Method 8082 Aroclor results as pie charts in river surficial sediments and the landside surface soils. The distinctly different Aroclor patterns in site surface soils versus the consistent river sediment Aroclor pattern are obvious. The Aroclor 1248 +1260 pattern is dominant in the river sediment, but rare is site surface soils. The combination of Aroclor 1248 +1260 was observed, however, in some Site subsurface soils. This Aroclor pattern difference corroborates the PCA distinction in cross plotted component scores for surface soils versus river sediments and some subsurface soils displayed in **Figure 4-21**. All river sediments and two of the three subsurface soils are grouped in the arc between Aroclors 1248 and 1260. The Site surface soil PCA scores plot outside this arc, indicating a different Aroclor pattern for Site surface soils versus river sediments. However, a forensics review of a number of other Site soil samples indicates that they are dominated by Aroclors 1248, 1254, and 1260 and confirms that preliminary PCB forensic analyses conclusions are sensitive to the selected sample set used in the analysis.

The distribution of total detected PCBs from EPA 8082 analyses in all site and background soil and sediment samples as box and whisker plots is presented in **Figure 4-22a** . The total PCB results are grouped by matrix and stream reach allowing comparison of site surface soils, site subsurface soils, site storm drain sediments, and site river sediments (all depths), upstream site-specific background sediments (all depths), and downstream site-specific background sediments (all depths). Frequency of detection (FOD) information is presented for each group as detected: total values. The gray box includes all results between the 25th and 75th percentiles, the line inside the box is the median value, the upper whisker represents the largest result less than or equal to the 75th percentile plus 1.5 times the interquartile range, and the lower whisker represents the smallest result greater than or equal to the 25th percentile minus 1.5 times the interquartile range. Results outside the whisker limits are represented by dots. **Figure 4-22b** presents the same dataset with outside values removed to better illustrate relationships between the bulk of the result values in the boxes. The median value of total PCBs in the background upstream river and Kingman Lake sediments is slightly higher at180 µg/kg than the median for site sediments of 160 µg/kg, although the frequency of detection is 50% upstream and 75% in site sediments. The 75th percentile and upper whisker concentration are also higher in site sediments than upstream background sediments. The background downstream sediments have a similar distribution to site sediments, although the total sample number is low, and the median value (75 µg/kg) is only ½ the site sediments median. These preliminary results might support the forensic pattern and spatial mapping analyses suggesting significant contribution to site sediments from upstream sources and relatively minor contribution to in-channel sediments downstream from the site. Subsurface site soils exhibited low PCB concentration relative to the other sample groups and a lower frequency of detection (35%), however, some site subsurface sample Aroclor patterns more closely matches the river sediment mix of Aroclors in some samples with the elevated concentrations. Site surface soils and storm drain sediment PCB totals however are elevated in comparison to site river sediments. Elevated site storm drain sediment PCBs may indicate a possible source of the elevated PCB concentrations in the Outfall 013 cove area from the surface to 7' depth shown in **Figure 4-11**; however, the current mix of Aroclors in the storm drain residues does not match the Outfall 013 cove sediments, except in sample SDR013N closest to the outfall. Outfall 013 sampling manhole location may be impacted by river sediments at high tide due to backflow from the River into the Site storm drain system. Most of the high outside values (dots above the upper whisker) in site sediments in **Figure 4-22b** are from this location or in deeper sediments near Outfall 101.

The congener profile of the groundwater sample in MW08BN2 shown in **Figure X-3** is an excellent match with Aroclor 1254 and this was the dominant Aroclor identified in the Method 8082 results from MW08BN and the field duplicate MW08BR. Aroclor 1260 was also identified in the Method 8082 results, probably due to the slightly elevated abundance of congeners in the PCB-170 to PCB-206 congener range, relative to the Aroclor 1254 pattern. PCB congener totals in MW08BN2 (82 ng/L) are also in excellent agreement with the Aroclor total of 93 ng/L for the mean of the normal and field duplicate sample data from Method 8082. Detection of both Aroclor 1254 and Aroclor 1260 in the groundwater at this well location is probably attributable to the nearby cooling tower source. The congener pattern in samples MW11AN2, MW04AN2, and MW07AN2 are also consistent with Aroclor 1254 and Aroclor 1260 as potential sources although lower molecular weight congeners in the PCB-4 to PCB-40/41/71 range are distorted by their higher water solubility, especially in MW7A. It is also possible that Aroclors 1242 or 1248 are contributing to the pattern because these Aroclors were detected in nearby soils, e.g. at SUS/DPS13. The congener totals in sample MW05BN2 are comparable to the equipment blank (EB2014129) and lab method blank (H5A06000034B), and biased by lab background congeners such as PCB-11, so potential field sources cannot be meaningfully assigned. Given the very low levels of PCBs detected, and the absence of a pattern match with site sediments, it is unlikely that groundwater flow is a significant contributor to PCBs in the river. However, as previously noted, because the subset of samples considered was limited, the above conclusions are tentative and will be subject to revision pending the completion of the upcoming, additional sampling event.

In conclusion, the preliminary PCB congener pattern analysis appears to confirm the qualitative Aroclor identifications by Method 8082 in almost all samples of the forensic sample subset analyzed by Method 1668. The results may support the use of the Aroclor data for additional forensic analysis; however, in the upcoming sampling event, additional sampling will include PCB congeners and any use of Aroclor data for forensic purposes will require additional evaluation. Cosine theta similarity analysis and Principal Component Analysis revealed a range of very similar patterns in all river sediment samples, both site related and in upstream background sources for the limited subset of samples evaluated. The river sediment pattern is attributable to mixtures of Aroclor 1248 and Aroclor 1260 in varying ratios and this combination is also revealed in a number of Site soil samples. Site surface and subsurface soils can exhibit different patterns of Aroclor type (dominated by Aroclors 1254, 1260, and 1242 in surficial soils) and congener relative abundance relative to river sediments. Elevated concentrations of PCBs near the 101 and 013 Outfalls may indicate localized historical contribution of PCBs to the river sediment from Site storm water discharges, however the near absence of detectable PCBs in the current site storm water indicate this is not a significant ongoing source to the river. On-Site groundwater PCB congener patterns were generally consistent with local known sources such as the cooling tower-adjacent soils and verified the Aroclor analysis qualitatively and quantitatively, however total PCB concentrations in groundwater are nondetect or very low, which reduces the groundwater usability for forensics.

4.9 Potential Sources of Constituents Detected in the Study Area

This section summarizes the understanding of the on-Site and off-Site sources that potentially cause or contribute to the impacts in Site media and Anacostia River sediments. **Table 4-22** summarizes the investigation results by Target Area. The investigation did not identify any non-aqueous phase liquids (NAPL). As discussed in the preceding sections and summarized in **Table 4-22**, various metals, PAHs, pesticides and dioxins were detected across the Site. The observed exceedances will be further addressed during the upcoming additional field investigation. The background sources are discussed in **Section 4.9.1** followed by discussion of the following potential on-Site source areas identified from the field sampling: (1) storm drains (TA #17); (2) PCBs in soils beneath and surrounding the concrete Cooling Tower basins (TA#5); (3) petroleum impacts in the AST Area (TA#13); and (4) a localized PCE groundwater plume along the southern Site boundary.

4.9.1 Background Sources

Multiple lines of available information indicate that there are numerous regional background sources that cause or contribute to PCBs, metals, PAH, pesticide, and dioxin/furan contamination. The background sources are discussed in Section 4.2 through Section 4.6 and include regional emissions from burning of fossil fuels, burning of fuels in automobiles, past practices such as open burning of trash, urban storm water runoff, atmospheric precipitation, pesticide residues from mosquito and termite control, etc. Sections 4.7 and 4.8 present a preliminary forensic analysis regarding the potential for onsite sources to contribute to PAH and PCB contamination in the Anacostia River. Although this preliminary analysis suggests that an important component of the observed river sediment contamination is from urban runoff sources, additional sampling for a broader range of hydrocarbon compounds and an expanded forensic analysis of site and background hydrocarbon data is necessary to more fully distinguish between background and Site contributions to sediment contamination.

4.9.2 Storm Drains

The majority of the storm water runoff from the facility is conveyed through a 48-inch diameter concrete pipe which becomes 54-inch as it discharges to the River via Outfall 013. This main 48/54-inch storm drain appears on facility maps as far back as the 1950s. Therefore, the storm drain system at the site appears to be over 60 years old. Notes on a storm system drawing indicate that the main 48/54-inch storm drain may have been connected to the city drains in Kenilworth Avenue at one time in the vicinity of Building 57 and subsequently plugged to eliminate discharge from Kenilworth Avenue. It is not known when the plugging of Kenilworth drains coming onto Pepco property took place.

As discussed in Section 4.8, the analysis of river sediment samples suggests that historical storm drain discharges may have contributed to PCB impacts near the outfalls. The near absence of PCBs from the storm drain water samples indicates that the Site storm drains are not currently a source of PCB contamination to the river. The Site currently employs various BMPs to control sediments and contaminants in storm water discharged from the Site, including the use of filters, screens and absorbent booms at all storm drain inlets. However, a minor contribution from accumulated sediments already present within the storm drain system cannot be ruled out. To address this, Pepco has recently conducted a closed-circuit television (CCTV) inspection of the storm drains and identified several areas with accumulated sediments. Pepco subsequently completed a clean out of the entire storm drain system, and removed all accumulated sediments (approximately 47 cubic yards) for off-site disposal.

4.9.3 Cooling Tower Building Materials

The superstructures of the power plant cooling towers were demolished in early 2014; only the foundational concrete basins remain onsite. Multiple soil sampling events have been conducted at the cooling towers (units 15 and 16) since 1995 to determine the potential impacts of PCBs from caulking material in the concrete basin expansion joints to the surrounding soils. Additional field program sampling, outlined in Addendum #2 to the RI/FS Work Plan (AECOM, 2014b), has been conducted to guide the development of a Soil Removal Action Plan (RAP) (AECOM, 2014c) for the soils beneath and adjacent to the cooling tower concrete basins.

Samples were collected to a maximum depth of 6 ft below grade (3 ft below the bottom of the basin concrete slabs) and a maximum distance of 15 ft from the basin walls. The maximum detection was 40 mg/kg PCBs at 1 foot below grade and 15 ft from the basin at the eastern end of unit 16. The results indicate that the majority of impacts are confined to the surficial 1 foot of soil surrounding the basins, with localized hotspots of deeper contamination >1 mg/kg PCBs, as deep as 5 ft below grade. Sub-slab soils were largely free of contamination except for a single location beneath unit 15 and two locations beneath the eastern portion of unit 16. In no cases was sub-slab contamination detected deeper than 2 ft below the bottom of the slabs.

Aroclor pattern analysis for the basin soils and basin building materials (expansion joint caulking and foam, concrete, and encapsulant) strongly suggests that PCB-contaminated materials in the basins are the source of PCBs in the surrounding soils. PCBs are suspected to have migrated from the basin materials into surrounding soils. Aroclor-1254 is the primary Aroclor in unit 15 building materials and soils. A higher proportion of Aroclor-1260 is present in soils surrounding unit 16, especially at the eastern end of the basin.

DOEE approved the final Soil RAP in July 2015. The Soil RAP proposes—at a minimum—the removal of a 15-ft wide, 3-foot deep strip of soil along the entire perimeter of both basins to remove surficial contamination. Wider and deeper spot excavations are then proposed for localized hotspot removal around the basin perimeters and below the slabs (following their removal). Hotspot excavation is proposed to a maximum depth of 6 ft below grade and a maximum distance of 20 ft from the basin walls. A program of post-excavation confirmatory sampling is proposed for the locations where contamination remains unbounded to ensure that all basin-impacted soils exhibiting PCBs greater than the remedial goal of 1 mg/kg are removed. A total of approximately 2,878 tons of soil from unit 15 and approximately 5,026 tons of soil from unit 16 are proposed to be removed and disposed of at an approved off-site disposal facility.

4.9.4 Petroleum Impacts in the AST Area

None of the soil samples collected during the RI activities exceeded the screening levels for TPH fractions (GRO, DRO, and ORO). Data collected from fourteen additional borings around the tank farm (Target Area #13) as part of the AST decommissioning program. Soil samples from two depths, 0-1 ft and 3-4 ft were analyzed for TPH, and a subset of soil samples were analyzed for metals, PAHs and PCBs. These results were provided to DOEE. The results indicate low levels of surficial TPH and PAH impacts (with the exception of one location adjacent to DP39), limited to the former AST dikes and the associated piping, which represent potential residuals from former cleanups. Soil sampling results from the AST decommissioning program are provided in **Appendix Y**. Sample location AST 3A exhibited a DRO concentration of 9,510 mg/kg in the surface soil, which exceeds the D.C. UST soil remediation standard of 960 mg/kg for DRO. Although below screening levels, other significant detections in this area are: a 320 mg/kg DRO and 1,700 ORO in a sample collected from 2.5-3.5 ft bgs at DP39 (**Figure 2-1**); and a DRO concentration of 357 mg/kg at 3-4 ft bgs at AST3A (**Appendix Y**).

All three ASTs were surrounded by circular reinforced concrete dikes and underlain by clay bottoms to contain any petroleum releases. There were no documented catastrophic releases from the ASTs.

Historical documentation indicates former releases of 100-2,000 gallons were contained within the diked areas and were promptly cleaned up. Therefore, the TPH levels observed in TA #13 appear to be related to residuals from former cleanups, but will be further addressed as needed in the upcoming field investigation. Forensic analysis also confirmed that the PAHs in the soil sample at DP39 are over 80% petrogenic, confirming the source to be petroleum spills. Several of the PAHs in soil exceed screening criteria and one PCB exceedance was noted in boring SB3. It should be noted that a revised CSM for the site will be prepared in conjunction with an additional sampling phase. The revised CSM will more clearly document the spills that have occurred and the potential that any undocumented catastrophic spills may have historically occurred.

Following the demolition of the ASTs, the surface was stabilized with gravel. Available data suggests that TPH impacts are limited to shallow soils. The aforementioned upcoming field sampling event will more fully address this contamination. Pepco will determine appropriate remedial actions for this area based on the results of a revised BHHRA to be completed in conjunction with the aforementioned additional sampling.

4.9.5 PCE Groundwater Plume

Twenty-three direct-push borings were installed between April 14 and April 18, 2014, near the southern site property boundary to delineate and help identify the source of PCE in groundwater in the UWZ at boring DP09. Twenty-three groundwater samples from the UWZ and three samples from the LWZ were collected and analyzed for PCE and its degradation products. Sample results for the PCE Source Investigation are provided in **Table 4-21**. A PCE groundwater plume isoconcentration map showing levels of PCE in the UWZ is provided as **Figure 4-23**.

The maximum concentrations of PCE, trichloroethylene (TCE), and cis-1,2-dichloroethylene detected in groundwater during the PCE Source Investigation were 470 µg/l, 26 µg/l, and 23 µg/l, respectively, all in sample DPWB730-35N. As shown in **Figure 4-23**, the >25 µg/l PCE plume in the UWZ was delineated to be approximately 500 ft in length along the southern Site boundary, and extends approximately 200 ft north into the Site. Levels of PCE, TCE, and cis-1,2-dichloroethylene in groundwater diminish rapidly with increasing distance north of Benning Road.

The three groundwater samples from the LWZ exhibited little or no PCE contamination. Groundwater sample DPWB545-50N exhibited the highest concentration of PCE in the LWZ (8.1 µg/l) and was the only LWZ sample containing detectable levels of a PCE degradation product (3.1 µg/l TCE). These data suggest that the formation in this area is in fact divided into an UWZ and LWZ by an intermediate semi-confining silt-clay layer and the impacts to the LWZ on Site are significantly lower than the UWZ.

PCE is not used in Site activities, and the distribution of PCE contamination in UWZ groundwater along the southern Site boundary strongly suggests an offsite source of PCE impacting groundwater. Although not currently used, in preparing the revised CSM for the Site, the potential that PCE or other solvents were stored and used at the site will be more fully investigated and documented. UWZ hydraulic gradients in this area (**Figure 3-9**) are shallow, and groundwater plume migration onto the Site from the south would be roughly cross-gradient. Furthermore, groundwater levels in the vicinity of the River are subject to tidal influence, which may cause periodic variations in local groundwater flow direction.

Upon review of the EDR package obtained for this RI Report (**Appendix J**), it was discovered that a dry cleaners, "Terrace Dry Cleaners," existed at 3427 Benning Road from 1969 to at least 1983. This address is directly across Benning Road from the approximate center of the onsite PCE plume. PCE is frequently used in dry cleaning agents, and PCE impacts to groundwater are commonly observed in the vicinity of dry cleaners. Given the age of the facility, the former dry cleaners is considered to be a potential source of PCE contamination in Site groundwater.

5 Contaminant Fate and Transport

This fate and transport analysis evaluates potential changes to identified Constituents of Potential Concern (COPCs) as they move through different environmental media. Understanding the fate and transport of Site constituents is important to the evaluation of their potential impacts to receptors. Transport is the simple movement of the constituents, for example, with the flow of groundwater or surface water. Fate is a summary of all the physical and chemical processes that act on the constituents during transport. The distribution of constituents at any given site is influenced by a combination of their physical and chemical properties, source nature, and their hydrogeologic and hydrologic setting.

Section 5.1 discusses typical fate and transport processes. Properties of various constituents identified at the Site are discussed in **Section 5.2**. A revised Conceptual Site Model (CSM) and site-specific migration pathways are discussed in **Section 5.3**. COPC mass flux calculations are presented in **Section 5.4**.

5.1 Fate and Transport Processes

5.1.1 Chemical Processes

Chemical transport is dependent on whether a chemical is present as a particulate, in the dissolved phase, or in the food chain. In the particulate phase, the chemical is fixed onto soil or sediment particles and therefore may be relatively immobile, particularly in the groundwater system, or may be subject to mobilization by the flow of water (e.g., in the riverine portion of the Site). In the dissolved phase, chemicals may move in groundwater or in surface water in the downgradient or downstream direction, although tidal forces in the Anacostia River also have the potential to introduce limited upstream transport. In the food chain, the mobility of certain compounds may be a function of the bioaccumulation potential, as well as the local ecology and habitats.

Some chemical specific measures, which are generally interrelated, that affect mobility include the following:

- The organic carbon partitioning coefficient (Koc) and octanol-water partitioning coefficient (Kow) are used to predict the degree of chemical sorption to soils, sediments, and particulate matter.
- The Henry’s Law constant describes the interaction between water and air and describes how readily a compound may volatilize from the dissolved phase.
- The water solubility and vapor pressure are factors that describe how a chemical maybe transition from the liquid, solid, and vapor phases, respectively.

- The biodegradation rate describes the rate that a chemical may break down; this value is site-specific, but in the absence of site data, literature values can be used.
- The bioaccumulation and biomagnification potential for hydrophobic organic constituents is often predicted by the Kow and can be used to predict which chemicals may be incorporated into the tissues of benthic or aquatic organisms.
- Certain inorganic constituents also have the potential to bioaccumulate and biomagnify in aquatic systems and often are characterized by a complex geochemistry involving organic and inorganic fractions.

Literature values have been compiled for the COPCs at this site (**Table 5-1**). Of particular note are the K_{oc} values for the semivolatile organic compounds (PAHs, PCBs, PCDDs/PCDFs, and organochlorine pesticides). Most of the COPCs have relatively high K_{oc} values (10^5 to 10^6). These high K_{oc} values are indicative of the tendency for these COPCs to strongly sorb onto soils and sediments and remain with negligible leaching back to water. The sorption is also a function of the organic carbon present in the existing soils and sediments. The higher the organic compound content the greater capacity for the soils to sorb chemicals. The other important factor for these semivolatile COPCs is the half-life values; these are long, weeks to months. For comparison the half-life for benzene is a matter of hours to days. The long half-lives for the COPCs suggest persistence in the environment. The tendency to sorb and the environmental persistence apply to the PAH's, PCB's, PCDDs/PCDFs, and organochlorine pesticides.

5.1.2 Physical Processes

5.1.2.1 Sediment

Sediments in the River may be affected by periods of high river velocities, storm events, and wind. Chemicals with low partition coefficients will tend to remain sorbed to sediment during these events, while chemicals with high partition coefficients may dissolve and enter the surface water or groundwater systems. River velocity and particle characteristics are the two main factors which influence the movement of sediment and sorbed chemical constituents. Sediments and other organic material (upon which chemicals are sorbed) are transported as they are suspended. Finer-grained materials are readily entrained in the river flow and transported downstream as suspended river load; coarser grained materials are heavier and therefore less likely to be transported under normal flow conditions, but may be move when river flow is larger. The Anacostia River is tidally influenced. Sediment transport models completed by others indicate riverine transport in the vicinity of the Site is typically in the downstream direction and that tidal changes do not move sediment upstream at this location (GeoSea, 2000).

Where the sediments and soils are deposited depends largely on river velocities; low velocity area will cause the suspended material to drop out faster than in high velocity areas of the river. Stream morphology is a good predictor of relative river velocity. For instance, in high energy/high velocity areas, erosional features such as steep river banks and incised channels are observed. In low velocity areas, depositional features such as sand bars and in-stream vegetation are observed. Given this pattern, it is assumed that higher concentrations of chemicals would be found in low velocity/low energy depositional environments. The higher concentrations of PCBs observed in the Outfall 013 cove mudflats and along portions of the eastern shoreline adjacent to the Site illustrate of this kind of situation.

Impacts to Anacostia River sediments in the Study Area are believed to be primarily the result of the transport and deposition of particulate matter from both erosion and surface runoff and point source discharges. Sediments may also be impacted by upwelling of shallow groundwater; however this is not considered a significant issue in the segment of the River within the Study Area. Bioturbation is the reworking of soils and sediments by animals or plants. During bioturbation, degradation rates may be higher because of oxygenation, but only for organic compounds subject to aerobic degradation. Degradation rates of highly chlorinated organic compounds do not change much by virtue of bioturbation.

5.1.2.2 Surface Water

Desorption from the surface-water entrained sediments is one source of chemicals to surface water. This mechanism characterized by partitioning coefficients and water solubility. Inorganic constituents in the Anacostia River surface water may occur in a variety of different forms, both as total recoverable and dissolved phase, although the dissolved phase typically represents the bioavailable fraction of this class of compounds. The water solubilities of high molecular weight PAHs, PCBs, dioxins, and organochlorine pesticides are very low and their affinity to attach to organic matter (higher partitioning coefficients) is high. As a result these compounds are not found in surface waters in soluble form. Vapor pressure and Henry’s Law Constant will describe how a chemical may partition between the water and the atmosphere. These processes are important for VOCs, which are not a concern at this Site. Groundwater discharge to surface water may also be a pathway from source areas to surface water, although this is not considered significant at this Site.

Once dissolved in the surface water, the transport properties of chemicals will be a function of the movement of the surface water, primarily surface water velocity and flux. For instance transport along concentration gradients may result in dispersion and dilution. Dilution can be estimated by comparing initial to final concentrations. In low velocity systems (i.e., marshes, wetlands) diffusion could be an important transport mechanism. Dissolved phase organic and inorganic constituents may become affixed to sediment and other particulate phases, as well as to organic ligands and other binding phases in the water column.

5.1.2.3 Soils

Surface water runoff, erosion, and dust are mechanisms for transport of impacted soil to wetland sediments and surface water. Man-made infrastructure (drains, sewers, culverts, outfalls) may also provide a mechanism for eroded impacted soil to migrate.

Chemicals that sorb strongly to soils (PAHs, pesticides, and PCBs, for instance) are likely to migrate with soil particles, i.e., erosion. Some chemicals (PCBs for instance) also do not degrade readily and may persist on soil particles. Other chemicals with low sorption potential and may leave the soil and migrate in dissolved water as surface water (perhaps to sediment) or as groundwater.

Constituent migration from soil to groundwater may occur when there is a source of soil impacts and recharge (rainfall) to prompt the migration. Because most of the Site is covered with impervious surfaces, there is minimal rainfall recharge at this Site. As a result, the soil-to-groundwater pathway is insignificant for much of the Site. Recent demolition of the power plant in the western portion of the Site will create some additional pervious area.

5.1.2.4 Groundwater

Groundwater may become impacted because of direct discharge to groundwater, because of leaching from soil to the groundwater, or because of migration within the groundwater system. As constituents in groundwater move through the groundwater system, a number of different processes act on them. These processes as a group are often referred to as attenuation processes, because they result in decreased concentrations of constituents over time and distance from a particular source area. These processes include groundwater velocity (advection), dispersion, retardation (adjusted velocity based on sorption/desorption, Koc) and degradation (half-life). Groundwater velocity is a function of changes in groundwater elevation over distance, porosity, and hydraulic conductivity. Hydrodynamic dispersion is the process whereby groundwater containing dissolved constituents must move around individual sand grains or other heterogeneities (variations) in the aquifer during groundwater flow. Together, advection, dispersion, retardation, and degradation attenuate constituent concentrations in groundwater with distance from a source area. Facilitated transport may also move hydrophobic organic contaminants through groundwater. Potential facilitated transport mechanisms include cosolvent facilitated transport and colloidal transport. Cosolvent facilitated transport can occur when NAPL, dissolved contaminants, or natural organic matter in groundwater increase the effective solubility and reduce soil sorption of hydrophobic organic contaminants. Colloidal transport can occur when colloidal size particles (generally < 10 microns) act as sorbents for hydrophobic organic contaminants and assist the movement through groundwater in spite of the low solubility of the contaminants in pure water.

5.1.3 Biological Processes

Bioaccumulation and bioturbation are factors that affect chemicals in the environment (persistence) relative to the nearby organisms. Bioaccumulation occurs when the uptake rate exceeds the organisms' ability to remove the chemical through metabolic functions including dilution and excretion resulting in storage of a chemical in the organisms' tissues. Biomagnification occurs at the higher end of the food chain, when persistent and bioaccumulative chemicals are passed from one organism to another through feeding processes. The source of chemicals to the organism may be sediment sorbed or dissolved phase, as well as through food chain uptake pathways (e.g., ingestion of contaminated prey items).

Bioturbation is the reworking of soils and sediments by animals or plants. In many quiescent systems, bioturbation is one of the primary factors affecting sediment stability (USEPA, 2005b). Many bottom feeding organisms physically move sediment during feeding, locomotion, nesting, and shelter building; however, with regard to sediment stability analysis, the most significant concern is "mixing zone" movement of sediment in the top 5 to 10 cm. The majority of organisms found in the sediment during historic macroinvertebrate community surveys of the Anacostia River were worms and oligochaetes (McGee *et al.*., 2009) which typically only bioturbate the top 2 to 3 cm of sediment (USEPA, 2005b). Therefore, it is unlikely that bioturbation will play a major role in modifying sediment stability in the Anacostia River at or near the Site.

The depth of sediment that is susceptible to mixing by various organisms varies with sediment grain size, density, chemistry, and habitat. Benthic insect larvae ingest bulk sediment and strip detritus from the surface of the particles, and may be exposed to sediment interstitial pore water. At this Site the primary COPC of interest relative to fish tissue residue is PCBs, which are both bioaccumulative and have the potential to biomagnify. Partitioned chemicals may enter the food web from uptake of sediment solids, food chain exposure pathways, or porewater/surface water interactions. **Figure 5-1** shows a conceptual exposure pathway for Waterside COPCs.

5.2 Constituents of Potential Concern

The following chemicals have been identified as COPCs within the Study Area as a result of the current sampling and data evaluations performed. This list may be modified based on the aforementioned revised CSM, the additional field sampling that will be performed, and subsequent analyses.:

- **Inorganics**: Arsenic, Barium, Cadmium, Chromium, Cobalt, Copper, Lead, Nickel, Thallium, Vanadium, Zinc

- **PAHs**: Anthracene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Pyrene, High Molecular Weight PAHs
- **PCBs**: Total PCBs
- **PCDDs/PCDFs**: 2,3,7,8-TCDD-TEQ
- **Pesticides**: trans-Chlordane, 4-4’-DDT, 4-4’-DDE, 4-4’DDD

These constituents were found in some or all of the following: surface soil, subsurface soil, storm drain residue, surface sediment, and surface water.

5.2.1 Inorganic Constituents

Adsorption is a key factor influencing the fate and transport of metals in the environment. The degree to which a metal will adsorb will depend on the presence of competing ions, metal speciation, and water chemistry, such as pH and redox, as well as dissolved organic carbon. Metals are found naturally in the earth’s crust in various forms. Metals identified as COPCs include: arsenic, barium, cadmium, chromium, cobalt, copper, lead, nickel, thallium, vanadium, zinc. Metals do not readily degrade in the environment. Metals that form stable oxyanions, such as arsenate and chromate, and do not form insoluble salts, are more generally more mobile in groundwater.

A review (**Table 5-1**) of the K_d (partitioning coefficients) provides an indication of the relative mobility of metals in ground and surface waters. For instance, vanadium has a high partitioning coefficient suggesting that it is hydrophobic, preferring to be sorbed. While chromium has a low partitioning coefficient suggesting that it prefers to be in solution. Both vanadium and chromium exhibit multiple oxidation states and speciation of these metals strongly effects their mobility in water. Certain divalent inorganic compounds (e.g., cadmium, copper, lead, nickel, zinc) have the potential to bind irreversibly to sulfidic phases in the sediment. Different forms of native and anthropogenically introduced organic carbon are also effective binding phases for many metals in riverine sediments such as the Anacostia.

Metals do not partition as strongly to organic material as hydrophobic organic compounds. However, the covariance of many inorganic compounds to sediment grain size has been well documented and is generally accepted by the scientific community (Klamer et al., 1990, SSC, 2003, Dashalakis and O’Connor, 1995). Coarse-grained sediments tend to have lower metals concentrations due to relatively low surface area available for metals sorption. Conversely, many compounds will tend to sorb to fine-grained sediment particles (Power and Chapman, 1992; USEPA, 2002). Additionally, when weathering breaks down minerals into clay particles, this fine fraction has higher metals concentrations in mineral matrices associated with naturally occurring background concentrations.

5.2.2 PAHs

Polycyclic Aromatic Hydrocarbons (PAHs) are ubiquitous in the environment, coming from both natural and anthropogenic sources. Types and sources of PAHs are discussed in more detail in Section 4.0 PAHs can be categorized into two classes: low molecular weight PAHs and high molecular weight PAHs. PAHs often occur together in the environment and many have similar toxicological effects, and environmental fate. PAHs in general do not easily dissolve in water and exhibit solubilities that are inversely proportional to molecular weight. They are semivolatile and hydrophobic, therefore can be present in air as vapors or adhere to surfaces of small solid particles. From surface water, some PAHs can evaporate into the atmosphere, but most stick to solid particles and settle to the bottoms of rivers or lakes. PAHs in urban river systems are often irreversibly bound (and thus not bioavailable) to organic carbon and black carbon (soot) in the sediment. In soils, the compounds are most likely to adhere tightly to particles, as indicated by the high Koc values in Table 5-1.

Certain PAHs in soils can also migrate to groundwater. Two and three ring PAHs (such as naphthalene, phenanthrene, and acenapthene) are the most soluble in water and likely to desorb from soil. PAHs can breakdown to less short-lived products by reacting with sunlight and other chemicals in the air, generally over a period of weeks to months. Breakdown in soil and water generally takes weeks to months. PAHs have been detected in groundwater either as a result of migration directly from contaminated surface waters or through the soil. They have been shown to be transported laterally within contaminated aquifers.

PAHs have limited bioaccumulation potential but can be found in plants, aquatic organisms, and animals from intake of contaminated water, soil, and food. In general, bioconcentration is greater for the higher molecular weight compounds than for the lower molecular weight compounds. However, extensive metabolism of the compounds by the high-trophic-level consumers (including humans) has been demonstrated, indicating food chain biomagnification of the compounds does not appear to be significant.

5.2.3 PCBs

Polychlorinated biphenyls (PCBs) are anthropogenic chemicals and have no known natural sources. Most PCBs in North America were produced as commercial mixtures called Aroclors and were often used in the past as dielectric fluids in transformers and capacitors. Production started in 1929 and was banned by EPA in 1979. A total of 209 individual PCB isomers, called congeners, are possible although Aroclor mixtures typically contain less than 160 congeners. PCBs exhibit low water solubility are moderately volatile, strongly adsorb to organics, and preferentially partition to soil and sediment. Solubility and volatility of congeners are both inversely related to molecular weight. The major fate process for PCBs in water is adsorption to sediment or other organic matter. Consequently, PCB concentrations in sediment and suspended matter are generally higher than in the associated water column (ATSDR, 1997a). The more highly chlorinated Aroclors sorb more strongly than the less chlorinated Aroclors, reflecting their differences in water solubilities and octanol-water partition coefficients. Adsorption and subsequent sedimentation may immobilize PCBs for relatively long periods of time in aquatic systems. However, limited re-dissolution into the water column may occur. PCBs contained in layers nearest the sediment surface may be slowly released over a long period of time. PCBs present in the lower layers of sedimentary deposits may be effectively sequestered from environmental distribution and slowly degraded by anaerobic microbial dechlorination under anoxic conditions (ATSDR, 1997a). Reductive dechlorination can alter the relative abundance of PCB congeners, but does not always significantly reduce the total mass of PCBs in sediment.

The estimated Henry's law constants for individual Aroclors indicate that volatilization may be a significant environmental transport process for PCBs dissolved in natural water. However, adsorption to sediment significantly decreases the volatilization rate of highly chlorinated Aroclors from the aquatic phase. The re-dissolution rate of PCBs from sediment to water is greater in the summer than in the winter because of more rapid volatilization from water at higher temperatures.

The ability of PCBs to bioaccumulate has been related to corresponding octanol-water partition coefficients (Kow). Compounds with high Kow values more readily bind to sediments (particularly sediments with elevated organic carbon) and are more readily bioaccumulated by organisms. Experimentally determined bioconcentration factors may depend on the water depth in which aquatic animals typically feed. PCBs also bio-magnify within the food chain. If consumed, PCBs are stored in fat and biomagnify up the food chain.

5.2.4 Dioxins

Polychlorinated dibenzo dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are a group of chemicals, commonly referred to as "dioxins", with both natural and anthropogenic sources. Many industrial combustion processes can produce trace levels of dioxins when chlorine is present, but dioxins were never intentionally produced for industrial uses like PCBs. These chemicals are extremely hydrophobic, almost insoluble in water, persistent in the environment, and they sorb strongly to soils and sediments. The isomer 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) is the most toxic dioxin and therefore the most frequently referenced in the literature. According to some studies, the ultimate sink of airborne particulate 2,3,7,8-TCDD is likely to be the sediments of surface waters (Choudry and Hutzinger, 1982; Czuczwa and Hites, 1986). Bacterial degradation of dioxins is possible but is very slow and is limited by the populations of organisms in native material. However, both volatilization and photolysis will slowly remove 2,3,7,8-TCDD from surface soils, surface water and groundwater.

5.2.5 Pesticides

The pesticides identified as COPCs were 4-4'-DDT, 4-4'-DDE, 4-4'DDD, and gamma-Chlordane (also called *trans*-chlordane). These organochlorine pesticides are hydrophobic anthropogenic chemicals that were widely used for insect control and are commonly found in urban soils and sediments. They tend to bioconcentrate and biomagnify in the food chain. Biotransformation proceeds at an exceptionally slow rate due to the complex aromatic ring structures and the extent of chlorination. 4,4'-DDT undergoes slow but extensive biotransformation in mammals and DDE is the major metabolite (aerobic conditions), with 4,4'-DDD as another metabolite (under aerobic conditions) (Callahan, 1979; Lichenstein and Schultz, 1959; Menzie, 1980). Organochlorine insecticides are not soluble in water. They have a rather high degree of lipid solubility as characterized by large fat-water partition coefficients which enables them to concentrate in tissue. Pesticides generally have low water solubility, and therefore are primarily in aquatic systems. Photo-oxidation of 4,4' DDT is known to occur on soil surfaces; however, it's not known to hydrolyze (Lichenstein and Schultz, 1959).

Studies have found that plants, fish, mammals, and birds as well as phytoplankton and zooplankton in aquatic environments bioaccumulate DDT. DDT has a high potential to bioaccumulate. In sediments, DDE is the major metabolite formed (Montgomery, 1996). Both DDD and DDE are stable and biologically active but DDE is non-insecticidal (Montgomery, 1996). DDT has a low solubility and preferentially binds to sediments. If consumed, DDT and metabolites are stored in fat and, as shown above, biomagnify up the food chain.

The fate and transport characteristics of trans-chlordane are similar to other organochlorine pesticides. Organochlorines tend to bioconcentrate and biomagnify in the food chain. Biotransformation proceeds at an exceptionally slow rate due to the complex aromatic ring structures and the extent of chlorination. Trans-chlordane is one isomer in complex mixture called technical chlordane that was most commonly used as a termiticide in urban areas. Trans-chlordane is semivolatile in air and insoluble in water.

5.3 Site-Specific Migration Pathways and CSM

A preliminary Conceptual Site Model (CSM) discussing sources of contamination, impacted media and routes of migration for the COPCs identified in various environmental media on the Landside and Waterside portions of the Site was presented in the RI/FS Work Plan. This preliminary CSM has been updated based on the RI field work completed to date. A further revision of this preliminary CSM will be prepared prior to the upcoming additional field investigation in consideration of available historical information regarding the 18 TAs and any other areas where hazardous materials may have potentially been handled, used, or stored. The data gap and uncertainties identified in this revised CSM will be addressed in the upcoming additional field investigation.

A general pictorial representation of the revised CSM is presented as **Figure 5-2** and described further in the following paragraphs. The CSM discussion in this section is limited to a discussion of preliminary Site knowledge regarding known sources, migration pathways, and potentially impacted media. Potential release mechanisms and exposure pathways related to human and ecological receptors are discussed in the BHHRA and BERA, respectively.

Compound transport can occur via a number of mechanisms, some responsible for the introduction of compounds into the river (e.g., runoff, bank erosion, point source discharges, and groundwater transport) and others that move compounds once in the river (e.g., bed erosion, surface water transport, bioturbation and food chain accumulation).

Although the human health and ecological risk assessments will be revised based on new data generated from the upcoming field investigation, this current version of the RI Report focuses only on Anacostia River sediments as the medium of concern. Additional media will be considered in the revised risk assessments to be documented in the final version of this report. The introduction of contaminants to the river sediments has resulted from various on-Site and off-Site processes. The potential for other on-Site processes, in addition to those shown below, will be assessed in the upcoming sampling event.

- Historical storm water and sediment discharges from the Site via Pepco’s storm drain system appear to have contributed to the COPC impacts observed near the Outfalls 013 and 101.
- Theoretically groundwater from the Site also discharges very low levels of COPCs to the Anacostia River surface water and sediments. Groundwater contribution from current and historical discharges of these low levels of COPCs is not a significant source of COPC impacts in the River.
- There are numerous other off-Site contributors (described in **Section 1.0**) who include:
  - Urban runoff
  - Upstream impacts (approximately 3/4 of the Anacostia Watershed is located in Maryland upstream of the District of Columbia in heavily urbanized Montgomery and Price George’s counties of Maryland)
  - Combined sewer overflows and contributions from tributaries such as Hickey Run and Watts Branch

  - Potential discharges from non-Pepco outfalls located in the Outfall 013 cove (it should also be noted that the Pepco outfall may also have received flows from Kenilworth Avenue in the past)
  - Potential discharges from other Sites (e.g., Kenilworth Park Landfill, Langston Golf Course, DPW Trash Incinerator, etc.) in the vicinity of the Pepco Site

Background and regional sources may be continuing sources of COPCs to river sediments. The Site may have historically contributed to river sediment contamination. However, at present and subject to findings from the additional sampling that will be performed, the Site does not appear to be a significant source of contaminants to the river based on the following:

- Based on available data, as subject to additional investigation, primary Site-related sources on the Landside were identified to be the residuals from former petroleum and PCB cleanup, minor spills/drips, past and present general industrial activities, and use of historical fill materials. Remedial activities and best management practices have largely mitigated on-Site sources and the nature and extent of current landside impacts indicate that no significant sources remain, with the possible exception of some soils immediately surrounding and beneath the concrete basins for the former cooling towers. PCB impacted soil in TA#5 (former Cooling Towers) appears to be impacting the shallow groundwater in its immediate vicinity. Extensive surface and subsurface soil sampling was conducted in this area in accordance with RI/FS Work Plan Addendum #2. Pepco is in the process of submitting a Removal Action Plan to remove impacted soils from this area.
- Currently, most of the Site surface is paved and/or otherwise stabilized. Therefore, erosion and migration of eroded soils is not identified as a significant transport mechanism.
- The Site currently employs various BMPs to control sediments and contaminants in storm water discharged from the Site, including the use of filters, screens and absorbent booms at storm drain inlets. However, a minor contribution from accumulated sediments already present within the storm drain system cannot be ruled out.
- Low levels of localized groundwater impacts were observed at the Site from a combination of the Site-related sources described in the first bullet and several potential off-Site sources (e.g., PCE in Site groundwater appears to originate from a former dry cleaners facility on Benning Road across from the Site; many dioxin sources exist in the vicinity of the Site including the heavy traffic corridor, a former incinerator, and historical open burning at KPN; potential groundwater metal transport from KPN Site [additional sampling to more accurately determine dioxin attribution will be performed in the upcoming sampling event],, etc.).

- Groundwater from beneath the Site discharges to the Anacostia River. Based on the low levels of COPC concentrations observed, a preliminary evaluation of mass flux suggests that neither current nor historical groundwater discharges from the Site are a significant contributor to the impacts in the Anacostia River. However, an additional sampling event will further investigate the elevated concentrations of several COPCs. Once this data is available the mass flux to the river can be more accurately evaluated and the revised result will be reported in the final version of this document. Based on the available data a preliminary mass flux of COPCs discharged through current discharges is further discussed in **Section 5.4**. The upcoming sampling event will include sediment pore water sampling as a means to more accurately evaluate the potential discharge of Site contaminants into the river. The potential for facilitated transport, as discussed in Section 5.1.2.4 above, will be also be evaluated as part of the upcoming field investigation.

Once introduced to the river, the fate and transport of contaminants is likely to be dominated, at least initially, by potential scour and downstream movement of sediment-associated constituents. Migration from the sediment pack directly into water in a soluble form is likely limited by the constituent’s relatively low solubility and the isolation of the higher constituent concentrations deeper in the sediment pack. While sediment scour and migration may occur episodically, the stability of the sediment pack adjacent to the Site and the minimal downstream impacts argue that such events are rare and do not affect a significant mass of sediment. Other fate processes (e.g., biodegradation, bioturbation) are not likely to be significant for constituents detected in sub-surficial sediments.

Organic COPCs such as PCBs, PAHs, pesticides, dioxins/furans exhibit strong affinities for organic material in sediments. Therefore, the suspension of these sediments largely controls the transport and distribution of these compounds within the river. In the vicinity of the Site, the environment seems to be more depositional than erosional. As a result, the impacts from constituent that may have been contributed to the river from historical Site discharges would be expected to be localized in the vicinity of the outfalls, as appears to be supported by the sediment sampling data. In particular, within the Study Area, PCBs and metals were detected at concentrations above regional background levels only the immediately area of the outfalls, with apparently negligible transport downstream.

5.4 Mass Flux Calculations

A preliminary mass loading calculation based on the available data was completed to estimate mass entering the sediment/surface water system via groundwater discharge to the Anacostia River. These calculations will be revised based on the results of the upcoming additional field investigation. The mass loading computations were performed using the sampling data from the six near-shore monitoring well pairs (MW-1A/B, MW-2A/B, MW-3A/B, MW-4A/B, MW-8A/B, and MW-11A/B). The calculations are summarized in **Table 5-2**. For calculation purposes, the values used were set to equal the detection limit or the estimated (J-qualified) value, as needed. These wells were selected because they are understood to represent groundwater quality discharging to sediments and ultimately to surface water. The groundwater flux over this area was calculated and presented in the HHRA. The product of groundwater flow and concentration yields the mass flux per well. As seen in **Table 5-2**, the mass loading of organic COPCs from groundwater to sediments and surface water is negligible. Mass flux of inorganics (which are natural and/or not Site related) appear to be within normal ranges. It should be noted that where the chemical was not detected the detection limits were used to calculate the mass flux; therefore the estimates are considered conservative (i.e., overestimates).

6 Baseline Risk Assessment

Using the dataset generated by the investigations documented in this report, a preliminary Baseline Human Health Risk Assessment (BHHRA) and a preliminary Baseline Ecological Risk Assessment (BERA) were performed. The BHHRA and BERA are presented in **Appendix Z** and **Appendix AA**, respectively. The reader should note that both risk assessments will be subject to revision pending the completion of a revised and expanded CSM and an upcoming, additional field investigation.

Both the preliminary human health and preliminary ecological risk assessments included an evaluation of multiple data sets, including:

- Anacostia River sediment chemistry;
- Anacostia River surface water chemistry;
- Anacostia River fish tissue residue chemistry (historic data set collected by others)
- Groundwater discharging from the Site to the Anacostia River

In addition, the human health risk assessment considered potential exposures to surficial and sub-surficial soils at the Landside Investigation Area. Pending completion of the upcoming, additional field investigation, the BHHRA will be expanded to include additional exposure scenarios.

6.1 Baseline Human Health Risk Assessment Summary

The preliminary BHHRA was conducted in accordance with the DOEE approved Risk Assessment Work Plan (AECOM, 2012a) as well as the resolution of responses to comments (AECOM, 2012b). In the absence of DOEE-specific guidance, and as discussed with DOEE staff, the BHHRA was conducted to comply with USEPA guidance for conducting a risk assessment.

The conclusions of the preliminary BHHRA for the Benning Road Facility are as follows:

Landside Investigation Area (All conclusions to be re-visited in the revised BHHRA)

- Based on a conservative screening-level evaluation, a limited number of inorganics, PAHs, PCBs, TCDD-TEQ (surface soil only), and TPH (subsurface soil only) were found to exceed screening levels. However, with the exception of PCBs, the concentrations of these constituents in the Landside soil are comparable to unrefined regional background levels. These results are preliminary as the background data analysis used in this screening (and described in Appendix V) will be revised and Site surface and subsurface data will be rescreened against the revised levels.

- Potential exposure pathways for on-Site surface and subsurface soils are currently incomplete due to perimeter fencing, 24-hour site security, and the presence of pavement or gravel across the vast majority of the Site. The current lack of access to soil is expected to continue into the foreseeable future. Although this preliminary BHHRA concludes an incomplete pathway for surface and subsurface Site soil, the revised BHHRA will consider these media through several additional exposure scenarios.
- There is no completed on-Site exposure pathway for Site groundwater, and this preliminary BHHRA concluded that that Site groundwater is not adversely impacting the Anacostia River. A possible exception is TCDD-TEQ in groundwater at MW-11. Elevated levels of TCDD-TEQ in groundwater at MW-11 are likely a result of high turbidity observed in this well, and thus, do not reflect dissolved concentrations that may be mobile and migrate to the river.

Therefore, based on this preliminary BHHRA, the conditions at the Landside Investigation Area do not pose any unacceptable human health risks. This conclusion will be re-visited in the revised BHHRA.

<u>Waterside Investigation Area (</u>All conclusions to be re-visited in the revised BHHRA)

- With the exception of fish consumption, none of the Waterside exposure routes were determined to pose an unacceptable human health risk
- Consumption of Anacostia River fish poses potential risks in excess of the USEPA's target risk level based on potential noncarcinogenic effects only. None of the potential cumulative receptor carcinogenic risks exceed the upper end of USEPA's target risk range of 10^{-6} to 10^{-4}.
- Potential noncancer risks for several hypothetical receptors (young child, older child, and adult angler) that consume a fish diet of all catfish or a mixed fish diet comprised of multiple species from the Anacostia River exceed the target human health hazard index (HI) of 1.
- Potential risks posed by direct contact with near-Site surface sediment and surface water in the Anacostia River adjacent to the Site do not exceed USEPA's target risk levels.
- PCBs in fish tissue is the dominant COPC and medium driving Site risk; other COPCs contribute negligibly to cumulative risk.
- Fish consumption risks estimated using data collected by DOEE and MDE at sampling locations throughout the Anacostia River exceed the noncancer target HI of 1 in all three segments of the river evaluated in the BHHRA, including the Lower Anacostia, Upper Anacostia

(which includes the stretch adjacent to the Site), and upstream of the Site in Maryland; these findings suggest multiple sources of PCBs in the River, including upstream of the tidal influence of the Benning Road Site. These results indicate that the potential for risk to certain human receptors from consumption of PCB-containing fish from the Anacostia River is a river-wide phenomenon, and thus cannot be solely or principally attributed to PCBs that originated from the Site.

6.2 Preliminary Baseline Ecological Risk Assessment Summary

The preliminary BERA was conducted in accordance with the DOEE approved Risk Assessment Work Plan (AECOM, 2012a) as well as the resolution of responses to comments (AECOM, 2012b). In the absence of DOEE-specific guidance, and as discussed with DOEE staff, the BERA was conducted to comply with USEPA guidance for conducting a risk assessment. The following conclusions are preliminary and will be re-visited in the revised BERA.

- Based on a screening level risk analysis, there is a limited potential for risk to the benthic macroinvertebrate community from exposure to COPCs in surficial sediments adjacent to the Site, especially in the vicinity of Outfall 013.
- Many of the COPC concentrations in surficial sediment adjacent to the Site are consistent with conditions at the Site-specific background sampling locations, and therefore the potential risks to the macroinvertebrate community cannot be solely attributed to Site-related sources.
- A screening level analysis of fish tissue data collected by DOEE and MDE at sampling locations throughout the Anacostia River indicates that there is limited potential for ecological risks to the fish community due to total PCBs tissue residue concentrations. However, based on the available data, this appears to be a river-wide phenomenon and assigning Site attribution is not possible.
- There is little to no potential for ecological risks to the wildlife community from ingestion of prey items containing PCBs and no additional wildlife risk analysis is warranted.

7 Summary and Conclusions

The purpose of the RI/FS 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 may be warranted. Through the development of a preliminary CSM, the sampling and analysis of multiple environmental media, and the performance of a Site-specific BHHRA and BERA, this RI Report documents the initial round of investigation, the results of which will be used to design a follow-up phase of investigation that will address the remaining data gaps and uncertainties at the Site. Once all such data gaps and uncertainties are addressed, a feasibility study will be performed to address the development and evaluation of potential remedial actions.

The RI/FS Study Area investigation consists of a “Landside” component focused on the Site itself, and a “Waterside” component focused on the shoreline and sediments in the segment of the River adjacent to and immediately downstream of the Site. To help guide the Landside Investigation activities, a total of 18 Target Areas (TAs) were identified on the Site based on historical investigations and remediation, UST closures, and former and current operations. The sampling program described below addressed all 18 TAs.

The following RI sampling activities were conducted on the Landside to date:

- Twenty-five (25) surface soil samples were collected at twenty-five (25) locations.
- One hundred thirty-three (133) subsurface soil samples were collected from multiple depths at forty-eight (48) locations.
- Eight (8) storm drain water and four (4) storm drain residue samples were collected from the onsite storm sewer system.
- Thirty (30) groundwater samples (15 from the UWZ and 15 from the LWZ) were collected from the 30 monitoring wells installed at the Site.
- To investigate the source of PCE in groundwater at location DP09, twenty-six (26) groundwater samples were collected using a screen-point sampler from locations near the southern Site boundary.

- To delineate PCBs in soils in the vicinity of the former cooling towers, two hundred seven (207) surface and subsurface soil samples were collected and analyzed from the area adjacent to and beneath the cooling tower concrete basins.

The following sampling activities were conducted during the RI Waterside Investigation:

- Twenty (20) surface water samples were collected at twenty (20) locations in the Anacostia River (ten locations within the Study Area and ten Site-specific background locations).
- Fifty-six (56) surface sediment samples and two hundred eight (208) subsurface sediment samples from multiple depths were collected at fifty-six (56) locations (forty-six (46) of the sediment sampling locations were within the Study Area and ten (10) were Site-specific background locations).

All samples collected during the RI field work were analyzed as outlined in the RI/FS Work Plan; analytes included inorganic constituents (metals), VOCs, SVOCs, PCBs, pesticides, dioxins/furans. Forensic samples were collected from different environmental media to facilitate contaminant fingerprinting and help determine the contribution of the Site to contamination in the River.

During performance of field activities, there were only a few deviations from the approved Work Plan. In a majority of cases, the deviations resulted in more work than the work plan required. Analytical data were validated in accordance with USEPA guidelines. A total of only 48 results out of 64,450 evaluated (0.074% of the total) were rejected; greater than 99.9% of the laboratory results were deemed valid and usable for project decisions. The project data quality objectives for measurement data were based on the assessment of precision, accuracy, completeness, sensitivity, comparability, and representativeness. The data validation confirmed that all of these measures were met. The analytical data were used to define the nature and extent of potential impacts.

7.1 Summary of Findings

Key findings from the Landside and Waterside Investigation Area RI activities conducted to date are presented below.

7.1.1 Geology and Hydrogeology

- The subsurface beneath the Site consists of three geologic units: historical fill material used to level the Site, Patapsco Formation underlying the fill, and Arundel clay underlying the Patapsco Formation. Fill material thickness averages about 5 to 8 ft across much of the Site, and up to 20 ft along subsurface utilities. The Patapsco Formation consists of a variegated mixture of brown and gray clays, silts, sands, and gravels. The Arundel Clay is a distinct regional confining layer, comprised of very stiff, fat, mottled maroon and dark grey clay. The Arundel Clay underlies the Site at a depth of between 45 and 85 ft bgs, and generally dips toward the west. Investigations at the Site did not penetrate through the Arundel Clay, which is reported to be as much as 100 ft thick.

- The subsurface investigation identified a silt-clay semi-confining layer underlying much of the Site and dividing the Patapsco Formation into an UWZ and LWZ. The top of the silt-clay layer was encountered between 25 and 40 ft bgs, and the layer averaged about 6 ft in thickness.
- The top of the water table aquifer (UWZ) generally ranges from 9 to 16 ft bgs. The piezometric surface of the LWZ aquifer at the Site generally averages 0 to 2 ft deeper than the UWZ water table.
- Groundwater elevation measurements at the Site indicate that the direction of groundwater flow in both aquifers is generally toward the River to the west, with slight local variations. Horizontal hydraulic gradients ranged from about 0.004 to 0.01 in the UWZ, and from about 0.005 to 0.008 in the LWZ.
- Evidence of tidal influence in groundwater from across the Site was apparent in both upper and lower aquifers. The greatest influence was observed at monitoring well MW-1 in the southwest corner of the Site, where groundwater levels in both the UWZ and LWZ varied by approximately 3 ft over a tidal cycle. Groundwater levels across the rest of the Site in both the UWZ and LWZ fluctuated by only 1 to 3 inches over a tidal cycle, and exhibited less variation with increasing distance from the River.
- The results of aquifer testing conducted in eight well pairs distributed evenly across the Site indicate that hydraulic conductivities in the UWZ and LWZ range from approximately 10^{-6} to 10^{-5} m/sec, which is consistent with unconsolidated deposits of silty sands or fine sands.

7.1.2 Nature and Extent of Impacts

7.1.2.1 Landside Investigation Area

- A limited number of metals, PAHs, and dioxins and furans were widely detected in most Target Areas and exceeded screening values in surface soils across the Site. A similar distribution was noted for these COIs in subsurface soils, except that dioxin and furans were present at concentrations below screening levels.
- PCBs were detected in soils at concentrations above screening levels at six surface sampling locations and two shallow subsurface sampling locations. Three of these detections were at former PCB cleanup areas, and the remaining detections are potentially related to historical leaks/spills.
- Additional field investigation is necessary to fully determine the nature and extent of the observed COIs. The background sources include but are not limited to regional emissions from burning of fossil fuels, burning of fuels in automobiles, past practices such as open burning of trash, urban storm water runoff, atmospheric precipitation, and pesticide residues from pest control. Additional

field sampling for background characterization purposes is proposed as part of the upcoming field investigation.

- A limited number of concentrations of metals, VOCs (primarily PCE and its daughter products), PAHs, pesticides, dioxins, and PCBs exceeded screening values in Site groundwater. Low levels of metals, pesticides and dioxins were the most widespread and exceeded screening values at various locations across the Site. PCE in the vicinity of DP-09 along the southern Site boundary is not considered to be Site-related. However, the source of PCE concentrations observed in MW-01 and MW-02 in the southwest corner of the Site is not known, and an additional field investigation will further address these detections. PAHs and PCBs were detected at concentrations above screening levels mostly in the western portion of the Site.
- Low levels of hydrophobic organics detected in groundwater (PAHs, pesticides, PCBs and dioxins) could be related to visibly turbid groundwater samples (i.e., could be present as entrained solids rather than as dissolved phase). In an upcoming additional field sampling phase, affected groundwater monitoring wells will be redeveloped and resampled to confirm the effect of sample turbidity on groundwater COI concentration levels.
- Several metals, PAHs, TPH, low levels of pesticides and PCBs were detected in storm drain residue and water samples. In general, the PCB levels in the storm drain residue samples were significantly lower than the levels reported in the USEPA (1997) Multi-Media Inspection Report. PCBs were nearly absent from storm drain water samples, except for one detection of 0.45 µg/L.
- For the most part metals, PAHs, pesticides, and dioxin constituents may not be Target Area related, but rather related to a variety of background sources. The observed COIs will be further addressed during the upcoming additional field investigation as needed.
- The investigation did not identify any non-aqueous phase liquids (NAPL) in Site soils or groundwater.
- An additional investigation is necessary to delineate the COI exceedances observed in this investigation. The additional investigation is needed in multiple locations including, but not limited to the following:
    - PCB impacts in soils around the cooling tower concrete basins (TA #5);
    - Petroleum impacts from historical spills in the AST area (TA #13); and
    - PCE in the vicinity of DP-09 is not considered to be Site-related. However, the source of PCE concentrations observed in MW-01 and MW-02 in the southwest corner of the Site is not known, and an additional field investigation will further address these detections.

The additional field investigation will be documented in an addendum to the RI/FS Work Plan that will be reviewed and approved by DOEE prior to its implementation.

7.1.2.2 Waterside Investigation Area

- Barium, two PAHs, one pesticide and dioxins and furans were detected in surface water samples from the Study Area at concentrations exceeding human health and/or aquatic life screening levels. The findings of this preliminary evaluation suggest that dissolved barium in surface water in the Study Area is consistent with Site-specific background in the Anacostia River. Average concentrations of one of the PAHs and the pesticide in Study Area and background samples are similar. Levels of dioxins and furans in Study Area samples are slightly elevated compared to site-specific background concentrations.
- Levels of all other organic and inorganic constituents in surface water in the Study Area are generally consistent with Site-specific background in the Anacostia River.
- A number of metals, PCBs, PAHs, and pesticide constituents were detected in surface and subsurface sediment samples within the Study Area at concentrations exceeding sediment screening values.
- The findings of the preliminary Background Evaluation for surface sediments suggest that:
    - Levels of cadmium, chromium, and zinc in surface sediment, in particular in the outfall 013 cove area, may be slightly elevated relative to Site-specific background;
    - The levels of some pesticides and PCDD/DF congeners in surface sediment within the Study Area, including Outfall 013 cove area, may be slightly elevated relative to Site-specific background;
    - Concentrations of PAHs, some pesticides, and BEHP in Study Area surface sediment are consistent with Site-specific background; and
    - The levels of PCBs in the vast majority of surface sediment in the Study Area are below 1 mg/kg; only seven (7) out of 237 samples contained concentrations of PCBs in excess of 1 mg/kg. PCB levels in surface sediment in the Outfall 013 cove area and along portions of the eastern shoreline adjacent to the Site extending up to the Benning Road Bridge are elevated relative to Site-specific background. In general, higher PCB concentrations were detected more frequently at shallower depths with the exception of a localized area north of the Benning Road Bridge.
- According to the 2009 USEPA SI Report, PAHs were detected in every sediment sample collected from the Anacostia River. There was no distinct spatial distribution of the PAHs detected. Based on the limited dataset available at the time, this document concludes that the presence of PAHs in the Anacostia River sediments appears to be indicative of ubiquitous conditions in the River, rather than releases from the Site. The current dataset plus the data that will be generated in the upcoming investigation will be used to update this conclusion, as appropriate.

7.1.2.3 Forensic Evaluation

- The preliminary forensic analysis performed for this first phase of investigation suggests that PAHs in Site soils and river sediments are potentially predominantly from combustion-related sources (pyrogenic) rather than fuels (petrogenic). A predominantly pyrogenic pattern can be consistent with PAHs from urban background sources, such as vehicular exhaust and road runoff that have been reported in other urban rivers and waterways. However, the list of PAHs considered by this analysis was limited and the results are inconclusive. The Site-specific background sample set will be expanded and additional analytes will be added to revise the forensic analysis as part of the upcoming additional investigation.
- The similar distribution of total PAHs detected in a limited number of upstream background sediments and near-Site sediments indicates that the Benning facility may not be a significant point source of PAHs in the Anacostia, but this assessment will be revisited in the upcoming additional investigation.
- Based on the limited number of samples analyzed, the Aroclor 1248 +1260 pattern appears dominant in the river sediment, but may be less dominant in Site surface soils. Background samples indicate a significant contribution from off-Site upstream sources to river sediments within the Study Area. The combination of Aroclor 1248 +1260 was observed, however, in some Site subsurface soils. Additional site investigations to characterize on-site and off-site PCB contamination sources will be performed using analysis of PCB congeners.
- Elevated concentrations of PCBs near the outfalls indicate that the outfalls may have historically contributed to the presence of PCBs in sediments via historical stormwater discharges. However, Aroclor pattern analysis, the near absence of detectable PCBs in the current Site stormwater, and negligible levels of PCBs in Site groundwater indicate the Site may not be a continuing source of PCBs to the River.

7.1.3 Fate and Transport

For the current investigation, with regard to the evaluation of potential human health and ecological risks, Anacostia River sediment is the medium of primary interest within the Study Area. In an upcoming, additional phase of investigation, other Site media will also be evaluated with regard to the potential for human and ecological risks. The introduction of contaminants to the river sediments appears to have occurred from a variety of sources.

There are limited pathways by which Site-related contaminants may migrate off-Site. Currently, most of the Site surface is paved and/or otherwise stabilized. Therefore, erosion and migration of eroded soils is not currently identified as a significant transport mechanism. The Site also employs BMPs to control sediments and contaminants in storm water discharge, including the use of filters, screens and absorbent booms at all storm drain inlets. However, a minor contribution from accumulated sediments already present within the storm drain system cannot be ruled out. Historical storm water and sediment discharges from the Site via Pepco's storm drain system may have contributed to impacts observed in surface sediments near Outfalls 013 and 101; however, several non-Site outfalls also discharge to these areas and may have contributed to the COPC levels observed in sediment.

Remedial activities completed or currently underway and BMPs have largely mitigated current on-Site sources. However, final assessment of source mitigation measures, completed or currently underway, will be an objective of the upcoming additional phase of investigation. Soils immediately surrounding and beneath the concrete basins for the former cooling towers are a known existing source for PCBs. PCB impacted soil in TA#5 (former Cooling Towers) appears to be impacting the shallow groundwater in its immediate vicinity. Extensive surface and subsurface soil sampling was conducted in this area in accordance with RI/FS Work Plan Addendum #2. Pepco is implementing a DOEE-approved Soil Removal Action Plan to remove impacted soils from this area.

Additional characterization will be performed to confirm whether or not the Site is a significant source of constituent transport to river sediments.

7.1.4 Background Conditions

There are numerous off-Site sources of COIs identified in the Study Area, including:

- Urban runoff;
- Upstream impacts (approximately 3/4 of the Anacostia Watershed is located in Maryland upstream of the District of Columbia in heavily urbanized Montgomery and Price George's counties of Maryland);
- Combined sewer overflows and contributions from tributaries such as Hickey Run and Watts Branch;
- Potential discharges from non-Pepco outfalls located in the Outfall 013 cove (it should also be noted that the Pepco outfall may also have received flows from Kenilworth Avenue in the past); and
- Potential discharges from other Sites (e.g., Kenilworth Park Landfill, Langston Golf Course, DPW Trash Incinerator, etc.) in the vicinity of the Pepco Site.

Background and regional sources may represent continuing sources of COPCs to the Anacostia River.

7.1.5 Human Health Risk Assessment

A preliminary evaluation of potential human health risks associated with potential current and future exposures was conducted. Health-protective assumptions and approaches were used to ensure that the results provide a conservative assessment of potential human health risks. The COIs were further evaluated in the preliminary Baseline Human Health Risk Assessment (BHHRA) and the preliminary Baseline Ecological Risk Assessment (BERA) to determine which COIs should be identified as Constituents of Potential Concern (COPCs). The results of the preliminary BHHRA will be used to help inform additional human health risk assessment following the completion of an upcoming additional phase of work. The preliminary BHHRA was conducted in accordance with the DOEE approved Risk Assessment Work Plan and USEPA guidance for conducting a risk assessment. The HHRA relied on Site-specific analysis of soil, groundwater, and sediment chemistry data, as well as an evaluation of regional fish tissue data collected by others. The conclusions of the preliminary BHHRA for the Benning Road Facility are as follows:

Landside Investigation Area

Based on the preliminary BHHRA, the conditions at the Landside Investigation Area may not pose any unacceptable human health risks. Based on current and anticipated future Site conditions and uses, direct current and future contact exposure pathways for on-Site soils may be incomplete or insignificant. To some extent, operational and institutional controls in place at the Site might prevent exposure. Potential additional exposures to landside soils will be revisited in the revised BHHRA following completion of an upcoming additional field investigation. The additional landside exposure scenarios will include a current/future construction worker, future industrial worker, and future recreational user.

Based on a preliminary conservative screening-level evaluation, a limited number of inorganic constituents, PAHs, PCBs, TCDD-TEQ (surface soil only), and TPH (subsurface soil only) were found to exceed screening levels. This screening will be revised following the upcoming, additional field investigation. However, the levels of dioxins and furans, PAHs, and inorganics in the landside soil are comparable to unrefined regional background levels of these constituents in soil. It should be noted that the background evaluation will be revised following the upcoming, additional field investigation. In the preliminary BHHRA, potential exposure pathways for on-Site surface and subsurface soils are assumed to be currently incomplete due to perimeter fencing, 24-hour site security, and the presence of pavement or gravel across the vast majority of the Site. The current lack of access to soil is expected to continue into the foreseeable future. However, the above-noted risk scenarios will be evaluated in the revised BHHRA.

One potentially complete exposure pathway for Site groundwater is migration to the Anacostia River. In-stream concentrations of constituents detected in groundwater at the downgradient edge of the property were preliminarily modeled using a conservative dilution attenuation factor. With the exception of TCDD-TEQ in one well with elevated turbidity, no modeled in-stream concentrations exceeded state and federal surface water screening levels, which indicates that Site groundwater is not adversely impacting the Anacostia River. However, additional assessment of potential groundwater contributions to adjacent river sediments will be performed in conjunction with the upcoming, additional field investigation.

Waterside Investigation Area

Waterside conclusions of the preliminary BHHRA are shown below. All conclusions are subject to modification based on the results of the revised BHHRA. With the exception of fish consumption, none of the Waterside exposure routes may pose an unacceptable human health risk.

- Potential risks posed by direct contact with near-Site surface sediment and surface water in the Anacostia River adjacent to the Site do not exceed USEPA's target risk levels.
- Consumption of Anacostia River fish poses potential risks in excess of the USEPA's target risk level based on potential noncarcinogenic effects only. None of the potential cumulative receptor carcinogenic risks exceed the upper end of USEPA's target risk range of 10^{-6} to 10^{-4}.
- Potential noncancer risks for several hypothetical receptors (young child, older child, and adult angler) that consume a fish diet of all catfish or a mixed fish diet comprised of multiple species from the Anacostia River exceed the target human health hazard index (HI) of 1.
- PCBs in fish tissue is the dominant COPC and medium driving potential Site risk; other COPCs contribute negligibly to cumulative risk.
- Fish consumption risks estimated using data collected by DOEE and MDE at sampling locations throughout the Anacostia River exceed the noncancer target HI of 1 in all three segments of the river evaluated in the BHHRA, including the Lower Anacostia, Upper Anacostia (which includes the stretch adjacent to the Site), and upstream of the Site in Maryland; these findings suggest multiple sources of PCBs in the River, including upstream of the tidal influence of the Benning Road Site. These results indicate that the potential for risk to certain human receptors from consumption of PCB-containing fish from the Anacostia River is a river-wide phenomenon, and thus cannot be solely or principally attributed to PCBs that originated from the Site.

7.1.6 Ecological Risk Assessment

The primary objective of the preliminary BERA was to evaluate whether or not populations of ecological receptors are potentially at risk due to potential exposure to chemical stressors in the Waterside Investigation Area. The BERA relies on Site-specific analysis of surficial sediment and surface water chemistry data, as well as an evaluation of regional fish tissue data collected by others. Since additional sampling will be performed in the upcoming sampling event, this preliminary BERA will be revised and reissued. The potential risks associated with the potentially complete exposure pathways in the Waterside Investigation Area were characterized using different screening level measurement endpoints, depending upon the available data; however, it is important to recognize that, consistent with the RI/FS Work Plan, no Site-specific biological or toxicological data were evaluated in this ERA. The BERA was conducted in accordance with the DOEE approved Risk Assessment Work Plan and USEPA guidance for conducting a risk assessment.

- Based on the preliminary screening level risk analysis performed in for this assessment, there is a limited potential for risk to the benthic macroinvertebrate community from exposure to COPCs in surficial sediments adjacent to the Site, especially in the vicinity of the River cove where Outfall 013 and three other non-Pepco outfalls discharge.
- Many of the COPC concentrations in surficial sediment adjacent to the Site are consistent with conditions at the Site-specific background sampling locations, and therefore the potential risks to the macroinvertebrate community cannot be solely attributed to Site-related sources.
- PCBs are present in fish tissue throughout the Anacostia River. Available data suggest that the fish from the river reach nearest the Site do not differ markedly from fish collected upstream or downstream of the Site. In fact, based on the limited available data, upstream concentrations of PCBs in fish tissue may be higher than fish collected from the reach adjacent to the Site.
- A screening level analysis of fish tissue data collected by DOEE and MDE at sampling locations throughout the Anacostia River indicates that there is limited potential for ecological risks to the fish community due to total PCBs tissue residue concentrations.   Based on the available data, this appears to be a river-wide phenomenon that cannot be attributed solely or principally to the Site.
- There may be little to no potential for ecological risks to the wildlife community from ingestion of prey items containing PCBs and it is possible that no additional wildlife risk analysis is warranted.

7.2 Conclusions

The Pepco Benning Road facility RI activities completed to date have resulted in a preliminary characterization of potential Site-related impacts on Landside and Waterside portions of the Study Area. An additional field investigation phase will be necessary to fully address the data gaps and uncertainties identified during the RI . Many of the constituents detected in the Study Area are consistent with background conditions, although this conclusion must be reassessed following additional field investigation to address the data gaps. Within the Landside Investigation Area, several COPCs are elevated in subsurface soil and groundwater at discrete locations within the Site. Within the Waterside Investigation Area, concentrations of several COPCs are elevated in the cove of the River into which Outfall 013 and three other non-Pepco outfalls discharge. The preliminary baseline human health and ecological risk assessments suggest that there are no potential risks associated with exposure to environmental media at the Landside Investigation Area, and that potential benthic macroinvertebrate exposure to surficial sediments within the Study Area is the sole potential exposure pathway warranting additional evaluation within the Waterside Study Area. However, following an additional phase of investigation, both the BHHRA and BERA will be revised using the additional data collected. The consumption of Anacostia River fish containing PCBs poses a potential risk to human health; however, fish throughout the river contain PCBs at similar concentrations, and thus potential human health risks cannot be solely or principally attributed to PCBs that originated from the Site.

7.3 Further Actions

Recommendations for interim actions on source areas identified during the RI activities conducted to date and for further data collection include but are not limited the following:

Interim Actions

Several interim actions have been completed, or are currently planned or under consideration at the Site.

- Excavation of PCB impacted soils from TA #5: Pepco has completed sampling to define the extent of PCB impacts and is in the process of obtaining DOEE's approval for a Removal Action Plan that will include excavation and off-site disposal of contaminated soil in this area.
- Petroleum Impacts in TA #13: If Pepco plans to reuse this area for purposes that require excavation or intrusive subsurface work, it is recommended that, pending the completion of a more comprehensive BHHRA, appropriate precautions be taken to reduce exposure to construction workers, and that any excavated soil be disposed of at an approved off-site disposal facility. No further sampling is necessary in this area.
- Storm Drains, TA #17: The Site currently employs various BMPs to control sediments and contaminants in storm water discharged from the Site, including the use of filters, screens and absorbent booms at all storm drain inlets. However, a minor contribution from accumulated sediments already present within the storm drain system cannot be ruled out. To address this, Pepco has recently conducted a closed-circuit television (CCTV) inspection of the storm drains and identified several areas with accumulated sediments. Pepco subsequently completed a clean out of the entire storm drain system, and removed all accumulated sediments (approximately 47 cubic yards) for off-site disposal.
- Pepco will develop a formal Soil Management Plan that will govern appropriate health and safety precautions to be used by any site worker involved in disturbing surface or subsurface soils at the Benning Road facility.

Landside Investigation Area

- Additional sampling and investigation is necessary to fully characterize the horizontal and vertical extent of impacts in the Study Area in order to understand the potential risks posed by the COPCs.
- Re-development and re-sampling of monitoring wells where hydrophobic organics were detected is needed.

Waterside Investigation Area

- It is recommended that additional Site-specific biological test data be collected to further evaluate the potential benthic macroinvertebrate ecological risk from exposure to the surficial sediments in the Waterside Investigation Area and to develop Site-specific action levels for consideration in the FS, if warranted.
- If it is determined that sediment management may be required in the cove where Outfall 013 and three other non-Pepco outfalls discharge, pilot studies and treatability studies are warranted. These studies may include gridding the area to better understand the volumes and surface areas of sediment to be managed, sediment dewatering studies, sediment treatability studies focused on analysis of sequestration agents (the use of amendments to reduce bioavailability of contaminants by sorption or biodegradation of contaminants) and other active and inert capping materials, and geotechnical evaluations to better understand sediment and bulkhead stability.

Pepco will prepare a final version of this document for DOEE review and approval once the following activities are completed: (1) additional field investigation sampling and analysis activities; (2) CSM revisions and expansions; (3) additional background characterization work, (4) Site characterization updates, (5) the BHHRA is expanded and revised, and (6) the BERA is revised. Once the RI is approved, additional engineering design data may be collected and the remedy selection process for the Landside and Waterside Investigation Areas can proceed in accordance with DOEE requirements to determine the most appropriate mechanism(s) to address the limited potential risks in the area.

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Figures

Tables

Appendices