Prepared for:
Pepco and Pepco Energy Services
Washington, D.C.

Prepared by:
AECOM
Beltsville, Maryland
September 2016

TECHNICAL MEMORANDUM #3 BASELINE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT WORK PLAN ADDENDUM

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

TECHNICAL MEMORANDUM #3
BASELINE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT WORK PLAN ADDENDUM

Benning Road Facility

3400 Benning Road, NE

Washington, DC 20019

PREPARED FOR:

Pepco and Pepco Energy Services
701 9th Street, NW
Washington, DC 20068

PREPARED BY:

AECOM
8000 Virginia Manor Road, Suite 110
Beltsville, MD 20705

September 2016

Maryann Welsch
Ecological Risk Assessment Lead

Kelly A.S. Vosnakis
Human Health Risk Assessor

Ravi Damera, P.E., BCEE
Project Manager

John Bleiler
Senior Technical Reviewer

Betsy Ruffle
Human Health Risk Assessment Lead

Contents

List of Tables

List of Figures

1 Introduction

This technical memorandum has been prepared by AECOM on behalf of Potomac Electric Power Company and Pepco Energy Services (collectively referred to as Pepco) for the Benning Road Facility (the Site), located at 3400 Benning Road NE, Washington, DC. The Site location is shown on **Figure 1-1**. The purpose of this technical memorandum is to outline the procedures for updating a previously submitted preliminary baseline human health risk assessment (BHHRA) and preliminary baseline ecological risk assessment (BERA).

A preliminary BHHRA and BERA were submitted to the District of Columbia Department of Energy and Environment (DOEE; previously referred to as the District Department of the Environment or "DDOE") along with the draft Remedial Investigation (RI) report (AECOM, 2016a,b,c) in April 2015; these documents were revised and finalized in response to DOEE comments in February 2016. The preliminary risk assessments were based on the results of RI field activities completed between January 2013 and December 2014. Both risk assessments concluded that additional field investigation is necessary to address remaining data gaps and uncertainties. A separate stand-alone work plan describing the addition RI field investigation (the Additional Remedial Investigation Work Plan) will be prepared and submitted to DOEE upon approval of this risk assessment Technical Memorandum #3, and two other technical memoranda (Technical Memorandum #1 [Conceptual Site Model] and Technical Memorandum #2 Background Evaluation).

Upon completion of additional field investigations, the preliminary BHHRA and BERA will be revised to include the results of these investigations, as discussed at the November 9, 2015 meeting. As requested in DOEE's January 16, 2016 letter to Pepco (RI Path Forward Letter), this technical memorandum describes the proposed revisions to the preliminary risk assessments to incorporate new Site data and additional landside exposure scenarios and address data gaps.

The work plan for revising and updating the preliminary BHHRA is presented in Section 2 of this technical memorandum, and the work plan for revising and updating the preliminary BERA is presented in Section 3. References are provided in Section 4. A brief overview of the Site is provided below.

1.1 Site Overview

The general Site location is shown on Figure 1-1. The Benning Road Facility is located on the east side of the Anacostia River approximately 4.7 miles upstream of the confluence of the Anacostia and Potomac Rivers. Together, the Site and the adjacent segment of the River are referred to herein as the "Study Area". The Study Area consists of a "landside" component which consists of the Site itself, and a "waterside" component which consists of 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 Benning Road Facility has been the subject of several Site investigations and removal actions since 1985; detailed discussions of the historical environmental activities at the Site are provided in Section 1 of the draft RI Report (AECOM, 2016a).

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 also included the Benning Road power plant until it ceased operation in June 2012. The Site is completely surrounded by a fence with two guarded entrances. The guard stations are manned 24 hours a day, 7 days a week. The majority of the Site is covered by impervious material such as concrete or asphalt. Storage areas not covered in impervious material are covered in 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.

As shown in Figure 1-2, land uses in the vicinity of the 77-acre Site include a mix of commercial, residential, parkland/green space, and transportation. The Site is bordered by a DC Solid Waste Transfer Station to the north, Kenilworth Maintenance Yard (owned by the National Park Service, NPS) to the northwest, the Anacostia River to the west, Benning Road to the south and residential areas to the east and south (across Benning Road). Major transportation corridors in the area include the Anacostia Freeway running north-south and East Capitol Street NE running east-west. The Minnesota Avenue Metrorail Station of the Washington Metropolitan Area Transit Authority (WMATA) light rail system is located immediately to the south of the Site.

The Site is located in Ward 7 in the District of Columbia, within the 20019 zip code (AECOM, 2013). Ward 7 contains a mix of residences and parkland, including Fort Mahan Park, Fort Davis Park, Fort Chaplin Park, Fort Dupont Park, Kenilworth Park and Aquatic Gardens, Watts Branch Park, Anacostia River Park and Kingman and Heritage Islands Park. The neighborhoods to the south of the Site along the east side of the river include River Terrace, Mayfair and Eastland Gardens. Four schools are located within a 0.25-mile radius of the Site boundary: Thomas Elementary School, Cesar Chavez Middle and High School, Benning Elementary School, and River Terrace Elementary School (Google Earth). Drinking water in the area is provided by a remote municipal source (DC Water) that originates on the upper Potomac River.

2 BHHRA Work Plan

The revised BHHRA will incorporate both the existing data as well as the data collected during the refined RI. The results of the BHHRA will be used to help inform the need for any additional evaluation and/or remedial action within the Study Area.

In the absence of DOEE-specific guidance, and as discussed with DOEE staff, the revised BHHRA will be conducted to comply with applicable USEPA guidance for conducting a risk assessment, as specified in the preliminary BHHRA (AECOM, 2016b). The revised BHHRA will follow the same methodology used in the preliminary BHHRA, including the evaluation of potential human health effects using the following four step paradigm, as identified by the USEPA (USEPA, 1989):

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

Where the methods and assumptions to be used in the revised BHHRA are the same as those presented in the approved Risk Assessment Work Plan (AECOM, 2012) and used in the preliminary BHHRA reviewed by DOEE (AECOM 2016b), they are not repeated in this Technical Memorandum.

2.1 Summary of Preliminary BHHRA

A preliminary BHHRA (AECOM, 2016b) was submitted to DOEE on February 26, 2016; this BHHRA was based on RI activities completed between January 2013 and December 2014. The preliminary BHHRA included a quantitative evaluation of waterside exposure pathways and a screening level assessment of potential landside exposure pathways, as summarized below

The primary objective of the preliminary BHHRA was to evaluate whether exposures to chemicals of potential concern (COPC) within the Study Area pose a potential current or future risk to human receptors who may come into contact with impacted media. The preliminary BHHRA relied on analysis of the draft RI data for landside surface soil, subsurface soil, and groundwater, and waterside surface sediment and surface water, as well as an evaluation of regional fish tissue data collected by others.

For the Landside Investigation Area, the preliminary BHHRA included a screening-level evaluation of on-Site soils consisting of a comparison of Site-wide maximum detected concentrations to conservative United States Environmental Protection Agency (USEPA) risk-based screening levels for industrial soil. The following constituents were found at concentrations that exceeded screening levels: certain inorganic compounds (arsenic, chromium, cobalt, thallium, vanadium), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxic equivalence (TEQ) (surface soil only), and total petroleum hydrocarbons (TPH) (subsurface soil only). Based on current Site conditions, the preliminary BHHRA concluded that potential exposures to on-Site surface and subsurface soils are currently incomplete due to perimeter fencing, round-the-clock Site security, and the presence of pavement or gravel across the vast majority of the Site. The current lack of access to on-Site soil is expected to continue into the foreseeable future, and quantitative evaluation of potential landside exposure pathways was not included in the preliminary BHHRA. A conservative screening-level analysis of landside groundwater found no potentially complete exposure pathways, with the exception of potential vapor intrusion into a potential future subsurface construction trench and potential off-Site migration to the river at concentrations above screening levels for TCDD in one well.

For the Waterside Investigation Area, the preliminary BHHRA included quantitative evaluation of several exposure scenarios, including occupational and recreational contact with surface water and surface sediment, and consumption of Anacostia River fish by anglers (the angler analysis focused solely on PCBs in fish tissue). The BHHRA found that potential human health risks posed by direct contact with nearshore surface sediment and surface water in the Anacostia River adjacent to the Site are within or below USEPA's target risk levels. Consumption of Anacostia River fish was found to pose risks in excess of the USEPA's target risk level for noncarcinogenic effects; cancer risks were found to be within the target risk range of 10^{-6} to 10^{-4}. For the young child, older child, and adult angler that consumes a diet of all catfish or a mixed fish diet comprised of multiple species, the potential noncancer hazards exceed the target hazard index (HI) of 1 due to PCBs (the only contaminant evaluated in the BHHRA). Fish consumption risks estimated using PCB data collected by DOEE and MDE at sampling locations throughout the Anacostia River were found to exceed the noncancer target HI of 1 in all three segments of the river evaluated in the preliminary 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.

2.2 Revisions to BHHRA for Landside Investigation Area

In accordance with the RI Path Forward Letter, the revised BHHRA will be expanded to include several new landside receptors and exposure scenarios to address the potential for Site uses to change in the future, as indicated below:

- Future construction worker – incidental ingestion and dermal contact with soil, inhalation of particulates and vapors from soil in outdoor air, and inhalation of vapors in an excavation trench in outdoor air.
- Future industrial worker - incidental ingestion and dermal contact with soil, inhalation of particulates and vapors from soil in outdoor air.
- Future recreational user – incidental ingestion and dermal contact with soil, inhalation of particulates and vapors from soil in outdoor air.

Section 2.6 presents a work plan for the evaluation of these new landside exposure scenarios, which will be evaluated in the revised BHHRA following the completion of the additional field investigation.

2.3 Revisions to BHHRA for Waterside Investigation Area

At the November 9, 2015 meeting, DOEE identified the evaluation of only PCBs in fish tissue as a data gap. It was agreed that the BHHRA would be revised to consider a broader array of COPCs in fish tissue, including the recent fish tissue data collected by DOEE as part of the ongoing Anacostia River Sediment Project RI (Tetra Tech, 2016).

Therefore, the BHHRA will be revised to include the additional river-wide fish tissue data that is now available (Tetra Tech, 2016), as well as historically collected non-PCB data, as appropriate. The same receptor scenarios, assumptions and methodologies evaluated in the preliminary BHHRA will be used in the revised BHHRA for the waterside area of investigation. The identification of COPCs will be performed using the most current screening levels available, which include USEPA residential soil Regional Screening Levels (RSLs) for surface sediment, DOEE surface water standards and USEPA water quality criteria and tap water RSLs for surface water, and USEPA RSLs for fish tissue. The updated COPCs will be evaluated in the revised BHHRA using current toxicity factors and the same approaches used in the preliminary BHHRA.

2.4 Data Evaluation and Hazard Identification

The additional analytical data to be collected in support of the RI will be incorporated into the existing Pepco project database. The relevant fish fillet tissue data collected under the Anacostia River Sediment Project RI (Tetra Tech, 2016) will also be included in the project database. The same steps used in the preliminary BHHRA to summarize the data by medium and analyte and calculate summary statistics will be applied.[1] An updated COPC screening will be performed for all media

[1] At the request of DOEE, the impact of using the average of the parent and duplicate versus a different statistic (e.g., the higher of the two) will be addressed during the data evaluation step in the revised BHHRA.

following the methodology used in the preliminary BHHRA, along with the most current USEPA Regional Screening Levels (RSLs), currently November 2015 (USEPA, 2015a).

As discussed in the preliminary BHHRA, the only potentially complete landside exposure pathway for groundwater is inhalation of volatile COPCs in an excavation trench. Because there are no relevant screening levels for this pathway, detected concentrations of volatile chemicals will be compared to the USEPA RSLs for tap water, based on a cancer risk level of $1x10^{-6}$ for potential carcinogens and a target hazard quotient (HQ) of 0.1 for potential noncarcinogens. Tap water RSLs are derived assuming consumption of water as a drinking water source, and are therefore conservative for the inhalation of trench air pathway.

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

As previously noted, a single well with elevated TCDD-TEQ (MW-11) was found to pose a potential threat to in-stream surface water based on a conservative screening evaluation that modeled concentrations in downgradient wells to the Anacostia River. However, the elevated turbidity identified in this well is not expected to be representative of dissolved groundwater concentrations that are mobile and may migrate off-Site. Thus, new groundwater data to be collected in the additional field sampling for downgradient wells will be used to update the groundwater-to-surface water screening in the revised BHHRA.

2.5 Dose-Response Assessment

Consistent with the preliminary BHHRA, USEPA's guidance will be followed in selecting dose-response values (USEPA, 2003). Two sets of PCB risk/hazard estimates will be presented for biotic media (as total PCBs and as dioxin-like congeners toxic equivalence [PCB-TEQ]), and abiotic media (e.g., soil, groundwater, air) will be evaluated as total PCBs.

2.6 Exposure Assessment

The purpose of the exposure assessment is to estimate the magnitude and frequency of potential human exposure to the COPCs retained for quantitative evaluation in the BHHRA. The exposure assessment discussion here is limited to the additional landside exposure pathways identified for inclusion in the revised BHHRA.

2.6.1 Identification of Additional Potential Landside Exposure Scenarios

The additional potential landside exposure pathways to be evaluated in the revised BHHRA are summarized below and presented in Figure 2-1.

Current/Future Construction Worker

A current and/or future construction worker may contact surface and subsurface soil during utility or other construction work requiring excavation into the subsurface. The construction worker is assumed to be exposed to soil via incidental ingestion and dermal contact as well as via inhalation of particulates and vapors from soil in outdoor air. The construction worker is also assumed to be potentially exposed to vapors migrating from the subsurface into the air of an excavation trench.

Future Industrial Worker

It is assumed that in the future, should current Site configuration with respect to soil cover change, that an industrial worker may contact surface soil. The industrial worker is assumed to be exposed to surface soil via incidental ingestion and dermal contact with surface soil, as well as inhalation of particulates and vapors from soil in outdoor air. The potential for future industrial workers to contact subsurface soil will be evaluated in the uncertainty section of the revised BHHRA.

Future Recreational User

Because the site is fenced and access is closely controlled, there is no current potential exposure to recreational users. In the future, if Site use or security changes, it is possible that recreational receptors could contact on-site surface soil. Therefore, the revised BHHRA will evaluate a future recreational user, potentially exposed to on-site surface soil via incidental ingestion and dermal contact with surface soil, as well as inhalation of particulates and vapors from soil in outdoor air. It is assumed that future recreational exposures will be limited to the western portion of the Site next to Anacostia Avenue (see Figure 1-2). This area is an open lot that was previously the location of the former power plant, which was demolished between 2012 and 2015. Per the National Contingency Plan (NCP) and applicable USEPA guidance, baseline risk assessments need to address reasonably anticipated future land uses (USEPA 1989 RAGS, USEPA 1995 Land Use Directive 9355.7-05). The Benning Road property provides essential space for storage, training, administration, and other industrial activities, and is critical to Pepco's current and future foreseeable operations. As previously described (see RI report and preliminary baseline human health risk assessment), the facility will continue to be used as a service center into the foreseeable future, due to the important role it serves in Pepco's electric transmission and distribution system in the District of Columbia. As such, the assumption of continued industrial use of the property in the foreseeable future is reasonable and appropriate. Pepco currently has plans to use the western portion of the property for Benning Service Center operations. In consideration of a remotely possible, but highly unlikely future change in land use in this area, a future recreational scenario for this open lot will be evaluated. Pepco has agreed to evaluate a future on-site worker's exposure to landside surface soil for the entire property. Soil exposure for an on-site worker who is assumed to have exposure to soil on 225 days per year would be greater than that of an occasional recreator; this will be further noted in the uncertainty section of the revised BHHRA.

The recreational user is also assumed to visit the off-Site parcel of land owned by the National Park Service that is located between the Site and the river (see Figure 1-2). This area will be evaluated as a separate exposure area for the recreational user, and is assumed to be both a current and future exposure scenario.

2.6.2 Quantification of Potential Exposures

To estimate human health risk from COPCs at the Site, it is necessary to estimate the potential exposure dose for each COPC. The exposure dose is estimated for each COPC for each exposure pathway by which the receptor is assumed to be exposed. Exposure dose equations combine the estimates of COPC concentrations in the environmental medium of interest with assumptions regarding the type and magnitude of each receptor's potential exposure to provide a numerical estimate of the exposure dose (intake). The exposure dose is defined as the amount of COPC taken into the receptor and is expressed in units of milligrams of COPC per kilogram of body weight per day (mg/kg-day) (USEPA, 1989).

Exposure doses are defined differently for potential carcinogenic and noncarcinogenic effects. The chronic daily intake is used to estimate a receptor's potential average daily dose from exposure to a COPC with noncarcinogenic effects. According to USEPA (1989), the chronic daily intake should be calculated by averaging the exposure dose over the period of time for which the receptor is assumed to be exposed. Therefore, the averaging period is the same as the exposure duration (ED) for COPCs with noncarcinogenic effects. For COPCs with potential carcinogenic effects, however, the chronic daily intake is calculated by averaging the exposure dose over the receptor's assumed lifetime (70 years). Therefore, the averaging period is the same as the receptor's assumed lifetime. The standardized equations for estimating a receptor's intake (both chronic and lifetime) are presented below, followed by descriptions of receptor-specific and chemical specific parameters.

<u>Estimating Potential Exposures to COPCs in Soil</u>

The following equations will be used to calculate the estimated exposures to COPCs in soil (USEPA, 1989, 2004).

Intake (lifetime and chronic) following incidental ingestion of soil (mg/kg-day):

$$Intake = \frac{CS \times \mathrm{IR_S} \times FI \times EF \times ED \times AAF_o \times CF}{BW \times AT}$$

where:

Intake	=	intake (mg/kg-day)
CS	=	soil concentration (mg/kg)
IRs	=	ingestion rate of soil (mg soil/day)
FI=	=	fraction ingested from Site (unitless)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (year)
AAFo	=	oral soil absorption adjustment factor (chemical-specific) (unitless)
CF	=	unit conversion factor (kg soil/10^6 mg soil)
BW	=	body weight (kg)
AT	=	averaging time (days)

Intake (lifetime and chronic) following dermal contact with soil (mg/kg-day):

$$Intake = \frac{CS \times SA \times AF \times EF \times ED \times DAF \times CF}{BW \times AT}$$

where:

Intake	=	intake (mg/kg-day)
CS	=	soil concentration (mg/kg soil – dry weight)
SA	=	exposed skin surface area (cm^2/day)
AF	=	soil to skin adherence factor (mg soil/cm^2)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (year)
DAF	=	dermal absorption factor (chemical-specific) (unitless)
CF	=	unit conversion factor (kg soil /10^6 mg soil)
BW	=	body weight (kg)
AT	=	averaging time (days)

Estimating Potential Exposures to COPCs in Air

The following equation is used to calculate the estimated exposure from COPCs in outdoor air or trench air.

Average Daily Exposure (Lifetime and Chronic) Following Inhalation of COPC (mg/m^3):

$$ADE = \frac{CA\,x\,ET\,x\,EF\,x\,ED}{AT}$$

where:

ADE	=	Average Daily Exposure (mg/m^3)
CA	=	Air concentration (mg/m^3)
ET	=	Exposure time (hours/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (year)
AT	=	Averaging time (hours)

2.6.3 Receptor-Specific Exposure Parameters

This section identifies the receptor-specific exposure parameters will be used to estimate exposure doses for the potential receptors in the revised BHHRA for the landside exposure scenarios. Both reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios will be evaluated. The CTE uses average exposure parameters to calculate an average exposure to an individual. The RME provides an estimate of the upper range of exposure in a population (the 90th percentile or greater of expected exposure, consistent with USEPA, 1992) and is based on a combination of the upper-bound and central estimates of exposure parameters.

Table 2-1 provides exposure assumptions for soil (ingestion, dermal contact, and inhalation) and **Table 2-2** provides exposure assumptions for the groundwater to trench air pathway. The majority of the exposure parameters are default values available from USEPA sources (USEPA, 2002d, 2004, 2011, 2014). Where default values were not available, the tables provide details regarding the assumptions made. Dermal contact and body weight exposure parameters for the older child/teen recreational receptor were calculated in **Tables 2-3** and **2-4**.

2.6.4 Chemical-Specific Parameters

The chemical specific parameters used in the equations above are discussed below.

<u>Dermal Absorption Fractions</u>

The dermal absorption fraction (DAF) accounts for lower absorption through the skin. USEPA chemical-specific DAFs will be used where available (USEPA, 2004).

<u>Oral Absorption Adjustment Factors</u>

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

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

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

For all soil COPCs except arsenic, a conservative default oral AAF value of 1 will be used, which is consistent with the approach used by USEPA in the derivation of RSLs (USEPA, 2015a). For arsenic, the default oral AAF of 0.6 will be used (USEPA, 2012). The use of the oral AAF for arsenic is also consistent with the derivation of soil RSLs (USEPA, 2015a). The impact of alternate AAFs will be discussed in the uncertainty analysis.

2.6.5 Exposure Point Concentrations

Exposure points are located where potential receptors may contact COPCs at or from the Site. The concentration of COPCs in the environmental medium that receptors may contact must be estimated in order to determine the magnitude of potential exposure. Consistent with the preliminary BHHRA (AECOM, 2016b), the exposure point concentration (EPC) will be defined as the upper confidence limit (UCL) (USEPA, 2002c) for the RME scenario, and the mean for the CTE scenario.

UCLs will be calculated using USEPA's ProUCL software (ProUCL Version 5.0, USEPA, 2013). The UCL recommended by ProUCL will be used unless determined to be inappropriate based on a statistical review, or if it exceeds the maximum detected concentration (USEPA, 2002c). The maximum will be used where the UCL exceeds the maximum, and the uncertainty associated with the corresponding risk estimates will be discussed in the uncertainty section of the HHRA.

The division of the landside property into exposure areas will be performed pending completion of the updated CSM and additional soil data collection. At this time, it is anticipated that it may be necessary to separate the Site into more than one soil exposure area, however, the identification of soil exposure areas for evaluation in the BHHRA will be completed once all available data have been evaluated.

Modeling will be required to estimate EPCs for the soil to outdoor air pathway as well as groundwater vapor to trench air pathway. The models to be used are discussed below.

Fugitive Dust

Outdoor air concentrations for the soil pathway will be calculated following the methods recommended by USEPA (2002d). For non-volatile COPCs, the particulate emission factor (PEF) will be used to estimate concentrations of COPCs in fugitive dusts. For volatile COPCs, the volatilization factor (VF) will be used to estimate concentrations of COPCs in outdoor air.

Trench Air

As noted previously, it is assumed that excavations into the subsurface will not result in standing water in the excavation trench. However, volatiles in groundwater beneath the trench floor may migrate upward into the trench air where construction workers may be present. In order to estimate concentrations of volatile COPCs that may migrate through the subsurface into the air of an excavation trench, VFs and subsequent trench air concentrations will be calculated using a model available from the Virginia Department of Environmental Quality (VDEQ)[2].

2.7 Risk Characterization

Consistent with the preliminary BHHRA, potential cancer risks and noncancer hazards will be calculated for each receptor using the same equations detailed in the preliminary BHHRA. The results will be compared to the applicable USEPA target risk range of 10^{-6} to 10^{-4} for potential carcinogens and a target HI of less than or equal to one for COPCs with noncarcinogenic effects (USEPA, 1990). Potential chemicals of concern (COC) will be identified in the BHHRA as those COPCs with individual cancer risks greater than 1×10^{-6} or that cause an exceedance of the HI of 1

[2] Vrp38.xls.
http://www.deq.state.va.us/Programs/LandProtectionRevitalization/RemediationProgram/VoluntaryRemediationProgram/VRPRiskAssessmentGuidance/Tables.aspx

for a particular target endpoint. The risk characterization will include a discussion of the major areas of uncertainty, and the potential impact on the risk assessment results.

2.8 Summary and Conclusions

The conclusions of the revised BHHRA for both the landside and waterside areas of investigation will be summarized. The receptor/exposure scenarios that pose potential risks in excess of the risk targets will be identified, and the COCs will be presented.

3 BERA Work Plan

The preliminary BERA provided a preliminary evaluation of potential risks to ecological receptors in a segment of the Anacostia River (the River) adjacent to Pepco's Benning Road facility (the Site), located at 3400 Benning Road NE, Washington, DC. The Site location is shown on Figure 1-1. The preliminary BERA focused solely on the evaluation of potential risks to ecological receptors in the Waterside Investigation Area.

This preliminary BERA technical memorandum work plan discusses how the earlier risk assessment will be revised based on the results of the additional field investigation.

3.1 Preliminary BERA Summary

The preliminary BERA (AECOM, 2016c) was originally submitted to DOEE in April 2015 and was revised and finalized in response to DOEE comments in February 2016. The primary objective of the preliminary BERA was to evaluate whether or not populations of ecological receptors are potentially at risk due to exposure to chemical stressors within the Anacostia River Waterside Investigation Area.

The preliminary BERA relied on analysis of available surficial sediment and surface water chemistry data, as well as an evaluation of regional fish tissue data collected by others. 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 no Site-specific biological or toxicological data were available for inclusion in this ERA.

The preliminary BERA acknowledged that: (1) there were uncertainties with the risk analyses, which were based on the RI activities conducted to date; (2) additional field investigation is necessary to address remaining data gaps and uncertainties; and (3) the preliminary BERA will be revised based on the results of these investigations and the revised ERA will include an updated summary and recommendations.

The following narrative summarizes the preliminary BERA conclusions:

Benthic Macroinvertebrates:

1. A number of COPCs are present in surficial sediment in the Study Area at concentrations in excess of low effect literature-derived Ecological Screening Values (ESVs). These include 13 metals, 11 pesticides, Total polychlorinated biphenyls (tPCBs), nine semi-volatile organic compounds (SVOCs), one VOC, and dioxin and furan compounds.

2. Relatively few COPCs are present in surficial sediment at concentrations in excess of probable effect ESVs. Compounds present at concentrations in excess of probable effect ESVs include cadmium, chromium, copper, lead, nickel, zinc, tPCBs, 4,4-DDD, 4,4-DDE, 4,4-DDT, trans-chlordane, total HMW PAHs, and bis-(2-Ethylhexyl)phthalate. Several dioxin and furan compounds exceed the low effect ESV; no probable effect ESV is available.
3. Analysis of factors such as Simultaneously Extracted Metals (SEM), total organic carbon (TOC), and Acid Volatile Sulfides (AVS) suggests that divalent metals in surficial sediment are largely not bioavailable.
4. Many of the concentrations of COPCs in the surficial sediment in the Study Area are likely to be consistent with background conditions. Review of Study Area data relative to background data collected in support of the RI indicates a high degree of concentration overlap among both organic and inorganic COPCs.
5. The highest concentrations of several COPCs in surficial sediments were found in the vicinity of Outfall 013 (Figure 1-2). These include inorganic COPCs, tPCBs, 4,4-DDT, and dioxin and furan compounds.

Based on this analysis, there is a limited potential for risk to the benthic macroinvertebrate community from exposure to COPCs in surficial sediments in the Waterside Investigation Area, especially in the vicinity of Outfall 013. However, for many of these COPCs, concentrations in surficial sediment in the Waterside Investigation Area are consistent with conditions at the background sampling locations, and therefore the risk cannot be solely attributed to Site-related sources. Additional field investigations and analyses were recommended to reduce the uncertainties associated with this preliminary ERA finding.

Fish Community:

1. The maximum concentrations of one metal (dissolved barium), one pesticide (4,4-DDT), and two SVOCs (anthracene and pyrene) were identified as COPCs in surface water. No other constituents in surface water exceeded low effect (chronic) ESVs. These compounds were also present at the background locations at concentrations in excess of chronic ESVs with the exception of pyrene.
2. No detected Waterside Investigation Area COPC concentrations exceed the acute ESVs.
3. The range of Study Area and Background surface water concentrations is similar.
4. No COPCs were identified in Site groundwater discharging to Anacostia River surface water and no significant risks to the aquatic community via this pathway were identified.

5. Although 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.
6. The range of tissue concentrations of total PCBs from all three river reaches evaluated was lower than the majority of no-observed effect concentration (NOEC) and lowest observed effect concentration (LOEC) tPCB critical body residues (CBRs).

Based on this analysis there is limited potential for ecological risks to the fish community in the Waterside Investigation Area due to total PCBs tissue residue concentrations. However, based on the available data, this appears to be a riverwide phenomenon and assigning Site attribution is not possible. This preliminary ERA finding will be updated in the refined BERA, which will include evaluation of a broader array of organic and inorganic fish tissue data, including analysis of data from the recently complete Anacostia River Sediment Project RI (, 2016).

Wildlife Receptor Risk Evaluation:

1. The evaluation of potential risks to wildlife in the Waterside Investigation Area focused on PCBs because they are expected to be the most relevant Site-related bioaccumulative compound within the exposure area.
2. Potential exposure of the raccoon, the belted kingfisher, and the great blue heron were evaluated in a food web model. Both average and maximum EPCs of sediment and surface water and available fish tissue data from the Upper Anacostia River Sampling Area were used to estimate exposure.
3. The PCB HQs for the raccoon, the belted kingfisher, and the great blue heron were below 1 under all exposure scenarios (i.e., considering maximum and average exposure point concentration [EPCs] and no adverse effect level [NOAEL] and lowest observed effect level [LOAEL] toxicity reference values [TRVs]). Therefore, risks to birds and mammals from exposure to PCBs within the Waterside Investigation Area are not expected.

Based on this analysis, there is little to no potential for ecological risks to the wildlife community in the Waterside Investigation Area from ingestion of prey items containing PCBs. This preliminary ERA finding will be updated in the revised ERA, which will include evaluation of wildlife consumption of prey items containing a broader array of organic and inorganic

constituents, including constituents in fish tissue collected as part of the recently completed Anacostia River Sediment Project RI (, 2016).

Additional field and laboratory activities designed to address the Waterside Investigation Area data gaps identified above are conceptually summarized in Section 3.2 of this work plan and will be detailed further in a forthcoming Additional Remedial Investigation Work Plan, which will be developed by PEPCO in conjunction with the DDOE. The approach for the refined BERA is described in Section 3.3 of this Work Plan.

3.2 Additional Data Collection in Support of the BERA

This section broadly outlines the field and laboratory tasks that will be completed by PEPCO in support of the refined Waterside Investigation Area BERA. PEPCO will submit a detailed Additional Remedial Investigation Work Plan (which will provide additional sampling and analysis plan details) to DOEE upon DOEE's approval of this Risk Assessment Work Plan, and approval of two other technical memoranda (Technical Memorandum #1 (Conceptual Site Model) and Technical Memorandum #3 (Background Evaluation).

Specifically, the following activities will be conducted in support of the BERA (Table 3-1):

- Sediment Profile Imaging (SPI) data collection
- Sampling and analysis of Anacostia River sediments
- Interstitial porewater sampling
- Benthic macroinvertebrate surveys
- Laboratory toxicity testing

3.2.1 Sediment Profile Imagery Reconnaissance Survey

A SPI reconnaissance survey will be conducted at 10 to 15 Waterside Area sampling locations and up to five reference locations to help identify the actual depth of the bioactive zone (BAZ) in this portion of the Anacostia River. For the purpose of the preliminary BERA (AECOM, 2016c), a conservative assumption was made that the BAZ was 0 to 6 inches (0 to 15 cm). This assumption may or may not be valid; a recently issued USEPA publication (USEPA, 2015b) emphasizes the critical importance of understanding the biologically relevant sampling depth in ecological risk assessments. This publication concludes that the BAZ in most estuarine and freshwater tidal environments is typically 10 to 15 cm (4 to 6 inches)

Given that the preliminary BERA (AECOM, 2016c) did not rule out the potential for risks to benthic ecological receptors, developing a better understanding of the BAZ will be important for the refined BERA, and is necessary in order to assess benthic faunal composition, and to better understand physical characteristics of the sediment. This imaging technique can identify chemical gradients related to the oxidative state of the sediment column and the presence of relatively large inventories of reduced gases (e.g. methane). Sediment profile imaging provides a reliable method to assess sediment-organism interactions and overall benthic habitat quality.

SPI Images will be scored for apparent redox potential discontinuity (RPD), grain size (minimum, maximum and major mode), and camera penetration depth (minimum, maximum and mean). The presence or absence of macroinvertebrate burrows, infauna, successional stage, anoxia, methane bubbles, and boundary roughness will also be recorded. Relative to determining the BAZ, the apparent RPD depth is an important measurement and will help determine the depth in the sediment at which there is a change in sediment color caused by a presumed strong gradient in oxidative versus reductive processes. The RPD depth depends on a variety of physical and biological factors that affect mixing and aeration of the sediment column such as turbulence, organic loading rates, rates of oxygen supply or degassing (ebullition) of methane.

The SPI work will be conducted prior to any other sampling and analysis activities for the Waterside Investigation area, thereby allowing the results of the SPI survey to inform the sampling depth for additional sediment chemistry, toxicology, and benthic macroinvertebrate analysis.

3.2.2 Sediment Sampling and Analysis

As part of the first phase of Waterside Investigation Area RI sampling, sediment samples were collected at 46 locations in the Waterside Investigation Area and at 10 Site-specific background sampling locations between November 5, 2013 and January 31, 2014. Surface sediment grab samples were collected from a depth of 0 to 6 inches below sediment surface using a Petite Ponar grab sampler. All samples were analyzed for TOC, grain size, metals, SEM and AVS, PCB Aroclors, and 16 polycyclic aromatic hydrocarbons (PAHs). A sub-set of samples were analyzed for VOCs, SVOCs, pesticides, and dioxin/furans.

To help refine the BERA, a total of 10 to 15 additional discrete surficial sediment samples (0 to 6 inches [0 to 15 cm] below river bottom, unless the SPI survey dictates an alternative sampling depth) will be collected from the Waterside Investigation Area. These samples will be collected for synoptic (in time and space) evaluation of benthic macroinvertebrate community heath, sediment chemistry (bulk sediment and pore water), and sediment toxicity. The results of these analyses will be used to support the BERA and if necessary the development of ecological remedial goals. In addition, five sediment samples will be collected at upstream reference locations for comparative purposes.

As described in the USEPA's (2001a) Method for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analysis: Technical Manual, the sampling station locations will be selected following a "Targeted Sampling Design" where prior knowledge of Site-related factors is incorporated into the process of selected station locations. Sampling stations will include:

- A range of reference condition locations with a range of known COPC concentrations (based on chemistry data available from nearby 2014 Site-specific background sampling locations included in the preliminary background evaluation and from sampling locations from the recently completed Anacostia River Sediment Project RI [, 2016]). Sampling at these locations will allow for interpretation of synoptically collected chemistry, biology, and toxicology data, will assist risk managers in understanding concentration-response curves, and will allow for consideration of the potential upstream anthropogenic inputs into this urban river system; and
- A range of locations within the Waterside Investigation Area selected to represent the chemical and spatial variability of COPCs within the urban river system (based on the RI data). Sampling at these locations will allow for interpretation of synoptically collected chemistry, biology, and toxicology data, and will assist risk managers in understanding concentration-response curves; and a geographic distribution designed to evaluate the potential risks associated with primary source areas.

Ten to 15 Study Area sampling locations will be identified in the forthcoming Additional Remedial Investigation Work Plan. These locations will be selected to represent a range of organic (e.g., total PCBs) and inorganic COPC concentrations in the Waterside Investigation Area and will be primarily located in the vicinity of Outfall 013 where the potential for risk to benthic macroinvertebrates was found to be highest. Proposed upstream reference area sampling locations are identified in the Technical Memorandum #2 (Background Evaluation) and will also be identified in the forthcoming work plan. These locations will likely include areas of the river that were not sampled by either Pepco in 2014 or Tetra Tech in 2014 or 2015. Ideal reference locations will be similar in grain size and TOC to the Study Area.

Co-located surficial sediment samples will be collected at each location for the following analyses:

- Chemical analysis of metals, PAHs (34 parent and alkylated PAHs), PCBs, TOC, SEM, AVS, dioxins, furans, and pesticides (the list of analytes will generally be consistent with the

COPCs evaluated in the preliminary BERA; physical parameters including grain size will also be measured);

- Interstitial pore water will be collected to support the BERA analysis and to develop a better understanding of the potentially bioavailable COPC fractions (see Section 3.2.3)
- Benthic macroinvertebrate community analysis to provide a measurement endpoint for evaluating the *in situ* response of the benthic community to potential stressors in the Waterside Investigation Area (see Section 3.2.4); and,
- Laboratory toxicity tests to evaluate whether direct exposures to sediments have the potential to cause toxicity to ecological receptors (see Section 3.2.5).

3.2.3 Porewater Sampling

Interstitial surficial sediment pore water sampling and analysis will be conducted in order to provide a better delineation of potentially bioavailable constituents in surficial sediments in the Waterside Investigation Area. Porewater sampling will be conducted synoptically with bulk sediment chemistry, macroinvertebrate community, and benthic toxicity testing sampling stations in order to support the BERA analyses.

Samples for pore water analysis will be collected from either the 0 to 6 inch (0 to 15 cm) horizon, or from a BAZ determined through evaluation of the SPI data collection (described above) using procedures outlined in the 2013 USEPA Pore Water Sampling Operating Procedure guidance document and passive sampling techniques (for instance, use of solid phase microextraction (SPME) techniques may provide a valuable tool for evaluation of hydrophobic organic constituents (e.g., PCBs and PAHs) in pore water).

Porewater will be analyzed for metals, PAHs, PCBs, ammonia, dissolved organic carbon (DOC), hardness, and potentially pesticides (the list of analytes will generally be consistent with the COPCs evaluated in the preliminary BERA).

3.2.4 Benthic Macroinvertebrate Surveys

A benthic macroinvertebrate community analysis will be performed at 10 to 15 Waterside Investigation Area sampling locations and up to 5 reference stations to provide a measurement endpoint for evaluating the *in situ* response of the benthic community to potential stressors in the Waterside Investigation Area. A review of macroinvertebrate community data collected recently by others suggests that a macroinvertebrate community is present throughout the Waterside Investigation Area, and that additional analysis of this community is warranted as part of the FS for the Site. Benthic macroinvertebrate samples will be collected at both Waterside Investigation Area and upstream reference sampling stations; the sampling will be conducted concurrently with other surficial sediment sampling activities described in this work plan. The results of the benthic macroinvertebrate community analysis will provide a direct measure of the integrity of the benthic community in relation to Site-specific chemical and physical stressors. Objectives of the benthic community evaluation include:

- Determining the abundance of macroinvertebrate infauna at sampling locations and within sampling reaches;
- Assessing the level of taxonomic diversity and evenness at selected sampling locations and sampling reaches; and,
- Evaluating the macroinvertebrate community structure relative to proximity to the Site and COPC sediment concentrations.

Biological impairment may be indicated by the absence of pollution-sensitive macroinvertebrate taxa, excess dominance by one taxon, low overall taxa richness, or reduced community composition relative to reference conditions. The protocols to be used for analysis of the benthic macroinvertebrate taxonomy and community results will be the metrics presented in the USEPA Rapid Bioassessment Protocol (Chapter 7; Barbour et al., 1999).

3.2.5 Laboratory Toxicity Testing

Laboratory toxicity tests are planned to evaluate whether direct exposures to sediments have the potential to cause toxicity to ecological receptors. All toxicity tests will be conducted under specified laboratory conditions using whole environmental media only (e.g., no dilution series toxicity testing is planned). Laboratory toxicity test sampling locations will be co-located in time and space with sediment chemistry, pore water, and benthic macroinvertebrate sampling locations, allowing for a detailed evaluation of the co-occurring data in the BERA. Sediment for laboratory toxicity testing will be collected from the 0 to 6 inch (0 to 15 cm) sampling horizon unless the results of the SPI survey indicate that an alternative sampling depth is best representative of the BAZ in the Waterside Investigation Area.

Chronic toxicity tests will be conducted to assess the toxicity of sediments to invertebrate organisms. The objective of the sediment toxicity tests will be to obtain laboratory data to evaluate potential ecological risks to invertebrate receptors. The midge (*Chironomus tentans*) and amphipod (*Hyalella azteca*) have been selected as the invertebrate species for a 10-day sediment toxicity testing program.

3.3 Refined BERA

The refined BERA will be conducted in accordance with the ERA Work Plan outlined in Appendix F of the December 2012 RI/FS Work Plan (AECOM, 2012). The ERA for the Waterside Investigation Area follows the tiered approach and methodology provided by the USEPA Ecological Risk Assessment Guidance for Superfund (ERAGS): Process for Designing and Conducting Ecological Risk Assessment, Interim Final (USEPA, 1997), Guidelines for Ecological Risk Assessment (USEPA, 1998), and The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments (USEPA, 2001b). The results of the refined BERA will be used to help inform the need for any additional evaluation and/or remedial action at the Site, and the Natural Resource Damage Assessment (NRDA).

The refined BERA will focus on the Waterside Investigation Area portion of the Site. This is consistent with the preliminary BERA in which the presence of the perimeter fence surrounding the Site and bulkheads along the shoreline was determined to limit any significant terrestrial ecological exposure for the Landside Investigation Area. The off-Site parcel of land owned by the NPS that is located between the Site and the river also has no significant ecological exposure due to the presence of fencing and bulkheads along the shoreline. In addition, the potential ecological habitats present on the NPS parcel are limited to the narrow strip of trees along the shoreline and a small wetland area near the Benning Road Bridge that is dominated by invasive common reed (*Phragmites australis*). Furthermore, no potential risks to wildlife were identified in the preliminary BERA or the river-wide RI (, 2016). Therefore, the refined BERA will characterize the potential risks associated with benthic and aquatic organisms present in the Waterside Investigation Area.

The preliminary BERA for the Waterside Investigation Area (AECOM, 2016c) can be considered the first tier of ERA for this portion of the Site and was designed to serve as Steps 1 and 2 of USEPA's eight-step ecological risk assessment process (USEPA, 1997, see Figure 3-1). At the end of Step 2 of this process, a scientific/management decision point (SMDP) is reached when a conclusion can be made that either (1) the available data indicate the potential for ecological risk and further investigation is warranted, (2) the available data indicate either no or low potential for ecological risk and no further work is warranted, or (3) there are data gaps that must be addressed before the presence or absence of risk can be concluded (e.g., additional sampling or analysis. As described earlier in this Work Plan, the DOEE and Pepco have determined that option 3 applies at the Benning Road Waterside Investigation Area (i.e., there are data gaps that must be addressed in order to refine the ecological risk analysis).

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

The general tiered approach of the ERA includes the following three main components:

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

Through this process, the CSM presented in the preliminary BERA (AECOM, 2016c; Figure 3-2) will be better defined and potential exposure pathways, ecological receptors, and risk assessment endpoints are identified.

3.3.1 Refined BERA Problem Formulation

Problem formulation is the initial step of the BERA process, and follows steps 1 and 2 (the SERA analysis) in the USEPA eight-step ERA process. In this step, the risk assessment data quality objectives (DQOs) are further defined, the goals and focus of the risk assessment are articulated, and a plan for assessing and characterizing the risks at the Site is determined. The information collected during problem formulation is used to refine the conceptual site model (CSM) developed during the SERA.

The problem formulation phase includes:

- Definition of risk assessment objectives
- Identification of COPCs
- Ecological characterization of geographic area to be considered
- Exposure pathway evaluation
- Identification of risk characterization endpoints
- Development of the CSM

3.3.1.1 Definition of Risk Assessment Objectives

The primary objective of the BERA is to evaluate whether or not populations of ecological receptors are potentially at risk due to exposure to chemical stressors in sediments within the Waterside Investigation Area.

3.3.1.2 Refinement of COPCs

Based on the results of the preliminary BERA, the COPCs warranting further consideration include a variety of organic and inorganic compounds, as detailed in Section 3.1.

3.3.1.3 Ecological Characterization of the Waterside Investigation Area

Section 2.4.1 of the preliminary BERA presents a detailed characterization and the results of the ecological Site visit for the Waterside Investigation Area. This ecological characterization will be updated in the refined BERA, as appropriate, to include additional ecological characterization data from the recently completed Anacostia River Sediment Project RI (, 2016).

3.3.1.4 Identification of Receptors and Potentially Complete Exposure Pathways

As described in detail in the Preliminary BERA (AECOM, 2016c), potentially complete exposure pathways were determined to exist for fish, benthic macroinvertebrates, and piscivorous wildlife. Therefore, the ecological exposure pathways to be evaluated in the Refined BERA include:

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

3.3.1.5 Identification of Assessment Endpoints and Measurement Endpoints

Assessment endpoints describe the characteristics of an ecosystem that have an intrinsic environmental value that is to be protected (i.e., protection of warmwater fish community). Typically, assessment endpoints and receptors are selected for their potential exposure, ecological significance, economic importance, and/or societal relevance.

Because assessment endpoints often cannot be measured directly, a set of surrogate ERA endpoints (measurement endpoints) are generally selected that relate to the assessment endpoints and have measurable attributes (e.g., comparison of media concentrations to screening levels, results of food web models) (USEPA, 1997, 1998). These measurement endpoints provide a quantitative metric for evaluating potential effects of constituents on the ecosystem components potentially at risk. Since each measurement endpoint has intrinsic and extrinsic strengths and limitations, several measurement endpoints will be used to evaluate each assessment endpoint.

The following assessment and measurement endpoints were selected for the refined BERA (based largely on the results of the Preliminary BERA):

- **Assessment Endpoint 1** – Protection and maintenance of freshwater benthic invertebrate populations in aquatic habitats within the Anacostia River typical of comparable aquatic habitats with similar morphology, hydrology, and urban setting.
  - **Measurement Endpoint 1a** – **Comparison of sediment concentrations to literature-derived sediment screening values**. Concentrations above the screening values are considered indicative of a potential for ecological risks. Comparisons between Site sediment concentration data and background sediment data will be used to distinguish between Site-related and system-wide (e.g., anthropogenic and natural background) conditions. The ecological screening values identified for the BERA will be used for this refined analysis, including the USEPA's Equilibrium Partitioning Sediment Benchmark approach for PAHs (USEPA, 2010).
  - **Measurement Endpoint 1b – Characterization of bioavailability potential in sediment based on Simultaneously Extracted Metals (SEM) and Acid Volatile Sulfide (AVS) relationships**. SEM/AVS ratios greater than one in a sediment sample are considered an indicator of potential bioavailability for divalent cationic metals. The SEM and AVS difference (SEM-AVS) and the influence of sediment organic carbon content was also considered in this evaluation. Evaluation of Site SEM, AVS, and Total Organic Carbon (TOC) data relative to Site-specific background SEM, AVS, and TOC data will be used to determine if bioavailability of divalent metals at the Site is similar in Site-specific background sediment.
  - **Measurement Endpoint 1c – Comparison of Study Area and reference area sediment toxicity bioassays**. Survival and growth measured in Waterside Investigation Area sediment will be compared to reference sediment to evaluate the potential lethal and sub-lethal effects associated with exposure to sediment.
  - **Measurement Endpoint 1d – Comparison of Study Area and reference benthic invertebrate communities.** Benthic macroinvertebrate community metrics measured in Waterside Investigation Area sediment will be compared to reference sediment to evaluate the potential chemical and physical stressors associated with Waterside Investigation Area sediment.

- Measurement Endpoint 1e – Comparison of porewater concentrations to literature-derived surface water screening values. Concentrations above the screening values will be used to help evaluate the Site-specific toxicity and macroinvertebrate data.

- **Assessment Endpoint 2** – Protection and maintenance of fish communities in aquatic habitats within the Anacostia River typical of comparable upstream aquatic habitats with similar morphology, hydrology, and urban setting.
  - **Measurement Endpoint 2a** – **Comparison of surface water concentrations to chronic and acute surface water screening values**. Concentrations above the chronic screening values will be considered indicative of a potential for ecological risks. Qualitative comparisons between Site surface water concentration data and Site-specific background data will be used to distinguish between Site-related and system-wide (e.g., anthropogenic and natural background) conditions.
  - **Measurement Endpoint 2b – Comparison of groundwater concentrations collected from nearshore monitoring wells to surface water chronic screening values**. Site-specific dilution factors will be applied to nearshore monitoring well groundwater data to provide a preliminary estimate surface water concentrations at the point of discharge to the River. Concentrations above the surface water screening values will be considered indicative of a potential for ecological risks and may warrant further evaluation through Site-specific modeling or additional data collection efforts.
  - **Measurement Endpoint 2c – Comparison of fish tissue COPC burdens to available critical body residue (CBR) thresholds and background tissue concentrations**. Concentrations above the no effect CBRs will be considered indicative of a potential for ecological risks. Qualitative comparisons between tissue residue concentrations from near-Site river reaches and the river reaches located downstream and upstream will be used to evaluate regional trends (e.g., anthropogenic and natural background) conditions. The preliminary BERA focused this analysis solely on PCBs; the refined BERA will include other organic and inorganic constituents when data (collected by others) are available).

- **Assessment Endpoint 3** – Protection and maintenance of a piscivorous vertebrate wildlife community in aquatic and wetland habitats within the Anacostia River typical of comparable aquatic habitats with similar morphology, hydrology, and urban setting.
  - **Measurement Endpoint 3a – Comparison of calculated potential daily exposure for avian and mammalian receptors from exposure to bioaccumulative COPCs in abiotic media (surface water and sediment) and ingestion of contaminated prey**

pepco
A PHI Company

items (fish) to constituent-specific toxicity reference values (TRVs). Estimated doses above the TRVs will be considered indicative of a potential for ecological risks. Qualitative comparisons between daily doses based on tissue residue concentrations from near-Site river reaches and doses based on tissue from the river reaches located downstream and upstream will be used to evaluate regional trends (e.g., anthropogenic and natural background) conditions. The preliminary BERA focused this analysis solely on PCBs; the refined BERA will include other organic and inorganic constituents when prey item tissue data (collected by others) are available).

3.3.1.6 Ecological Conceptual Site Model

An ecological CSM was developed in the Preliminary BERA (Figure 3-2) to provide a clear and concise description of how ecological receptors may come into contact with COPCs via release mechanisms and exposure to sediment, surface water, or fish tissue. The preliminary BERA ecological CSM provides a schematic representation of the potential COPC release mechanisms, the exposure pathways, and potential ecological communities or wildlife receptors to be assessed. The overall RI CSM is currently being updated and the ecological CSM will be updated accordingly in the revised ERA.

3.3.2 Refined BERA Risk Analysis

The Risk Analysis phase will include evaluation of earlier RI data, as well as the newly collected data described in Section 3.2, to characterize potential ecological exposures and effects. When appropriate, newly collected data from the recently completed Anacostia River Sediment Project RI (, 2016) will also be incorporated into the refined BERA (e.g., fish tissue data).

3.3.2.1 Data to be Evaluated

The following data sets will be evaluated in the risk assessment:

- SPI data (to help determine the Site-specific BAZ);
- Surficial bulk sediment chemistry data (including data evaluated in the preliminary BERA, as well as 10 to 15 additional surficial sediment chemistry samples to be collected in support of the refined BERA);
- Fish tissue data (collected by others);
- Groundwater data from the Landside portion of the Site (to evaluate the potential for discharge to the Anacostia River);
- Surficial sediment interstitial pore water data;

- Benthic macroinvertebrate community data; and
- Sediment toxicity testing data

The additional analytical and biological data to be collected in support of the RI will be incorporated into the existing Pepco project database. The same data treatment procedures used in the preliminary BERA to summarize the data by medium and analyte and calculate summary statistics will be applied in the refined BERA. An updated COPC screening in sediment will be performed for all measurement endpoints described above following the methodology used in the preliminary BHHRA. Porewater will be screened against the surface water ecological screening values (ESVs). The fish tissue residue risk analysis will be expanded to include a broader array of organic and inorganic COPCs in fish tissue and will consider the most recent fish tissue data collected as part of the ongoing Anacostia River Sediment Project RI/FS.

3.3.2.2 Risk Analysis for Lower Trophic Level Receptors

As described above, a number of measures of effect will be used to evaluate the assessment endpoints developed for lower trophic level receptors (i.e., fish and benthic macroinvertebrates). Analytical chemistry analyses, toxicity testing, and field-collected tissue data analyses (collected by others) will allow for direct evaluation of relationships between biological endpoints and chemical stressors in the BERA.

To help focus the analysis of the BERA field program results, sediment analytical chemistry analysis results will be compared to benchmark screening levels. The sediment dataset will include surface sediments collected in the original RI program as well as in support of the refined BERA. The sediment screening levels will include the levels which were presented in the preliminary BERA.

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

- If the $(\sum SEM\text{-}AVS)/f_{oc}$ excess exceeds 3000 µmol/g_{oc}, the sediments are presumed to be "likely to be toxic";
- If the $(\sum SEM\text{-}AVS)/f_{oc}$ excess is between 130 and 3,000 µmol/g_{oc}, predictions of effects are uncertain; and

- If the (∑SEM-AVS)/f_{oc} excess is less than 130 µmol/g_{oc}, the sediments are presumed to "not likely" be toxic.

To evaluate potential exposure to and effects from COPCs in sediment, two invertebrate species (a midge (*Chironomus tentans*) and amphipod (*Hyalella azteca*)) will be exposed to Waterside Investigation Area sediments in controlled laboratory toxicity tests. Sediments from reference sampling stations will be tested concurrently in order to control for Site-specific variables, such as grain size, TOC, and constituents from upstream sources. Tests will be conducted on a total of 10 to 15 Site sediment samples which will be co-located with synoptically collected analytical chemistry samples. Standardized statistical tests, such as analysis of variance (ANOVA) will be conducted to determine if significant differences in survival, growth, or other measured responses were observed in Site sampling locations relative to the reference locations. In addition to these statistical tools, the evaluation of toxicity testing data may include pooling of Site data for comparison to the upstream data, evaluation of Site data relative to various literature-derived numeric thresholds for mortality, and evaluation of data within one section of the Waterside Investigation Area relative to another section of the Study Area to attempt to elucidate stressor causality. A similar analysis will be conducted with the macroinvertebrate community data, to evaluate trends in populations and communities of these receptors at the Site. Attempts will be made to relate the results of the toxicity-testing program and the macroinvertebrate community sampling program with measured concentrations of target chemicals to develop potential associations between observed toxicity, community health impacts, and chemical concentrations.

A CBR analysis will be conducted in an attempt to evaluate impacts on the aquatic community associated with tissue residues. CBRs are presumed to represent tissue concentrations resulting from actual exposures that could potentially result in adverse biological effects. Rather than selecting one individual effects-based CBR for evaluating potential effects of COPC residues, the tissue data will be evaluated in the context of a number of different studies. Sources of CBR values were presented in the preliminary BERA.

3.3.2.3 Higher Trophic Level Risk Analysis

A food chain model will be used to evaluate potential ecological risk via bioaccumulation pathways to representative mammalian and avian receptors that may feed on Waterside Investigation area prey items and may potentially be exposed to COPCs found in the sediment. These food web models were described in detail in the preliminary BERA and will be updated for the refined BERA to include COPCs other than COPCs, which were the sole constituents evaluated in the preliminary BERA food web models.

As in the preliminary BERA, the following piscivorous wildlife receptors will be evaluated in the refined BERA food web model:

- **Great Blue Heron (*Ardea herodias*)** – The great blue heron was selected as a representative avian piscivore for evaluation of potential risks associated with exposure through the ingestion of fish. The great blue heron occupies a variety of freshwater and marine areas, including brackish marshes, coastal wetlands, lakes, and rivers where small fish are abundant in shallow areas. Fish are preferred prey, but they also feed on amphibians, reptiles, insects, crustaceans, birds, and mammals (USEPA, 1993). The great blue heron is a wading bird and not likely to be found in deep water.
- **Belted Kingfisher *(Megaceryle alcyon)*** – The belted kingfisher was selected as an additional piscivorous avian receptor for the evaluation of potential risks associated with exposure through ingestion of fish. The belted kingfisher inhabits shorelines of rivers, streams, and estuaries and feed on fish swimming near the surface or in shallow waters. In addition to fish, belted kingfishers consume crayfish, crabs, mussels, small amphibians and reptiles such as frogs and lizards, young birds and mice, and berries (USEPA, 1993). The belted kingfisher feeds by diving head first into the water, and water depths of 60 cm or less is preferred (USEPA, 1993).
- **Raccoon (*Procyon lotor*)** – The raccoon was selected as a representative small omnivorous mammalian wildlife species that may be found within aquatic exposure areas. The raccoon is the most abundant and widespread medium-sized omnivore in North America. Raccoons are commonly found in aquatic habitats, particularly in hardwood swamps, floodplain forests, and freshwater and saltwater marshes. They are also common in suburban residential areas. Raccoons are omnivorous and feed primarily on insects, small mammals, birds, lizards, and fruits (USEPA, 1993). The raccoon is expected for forage on the nearshore and banks of the Waterside Investigation Area, and is unlikely for forage in deep waters.

3.3.3 Refined *BERA Risk Ch*aracterization

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

The BERA will integrate a variety of methodologies to assess potential ecological risks. The conclusions regarding overall risk(s) to ecological receptors will be based on a weight-of-evidence approach, which will consider the results of all components of the assessment methodology (i.e., an approach that integrates results of physical, biological, toxicological, and field measurement endpoints to draw risk-based conclusions). The weight-of-evidence components will be designed to provide measures of potential risks for different ecological receptors and exposure pathways.

4 References

AECOM. 2012. Remedial Investigation and Feasibility Study Work Plan. Final. Benning Road Facility. Prepared for Pepco Holdings, Inc. December 28, 2012.

AECOM. 2013. Community Involvement Plan. Final. Benning Road Facility. Prepared for Pepco Holdings, Inc. February 2013.

AECOM. 2016a. Remedial Investigation Report. Draft. Benning Road Facility. Prepared for Pepco Holdings, Inc. March.

AECOM. 2016b. Preliminary Baseline Human Health Risk Assessment. Draft. Benning Road Facility. Prepared for Pepco Holdings, Inc. February.

AECOM. 2016c. Preliminary Baseline Ecological Risk Assessment. Draft. Benning Road Facility. Prepared for Pepco Holdings, Inc. February.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

. 2016. Phase I Remedial Investigation Report. Anacostia River Sediment Project. Department of Energy and the Environment Government of the District of Columbia. Prepared by. March 18, 2016. Draft.

USEPA. 1989. Risk Assessment Guidance for Superfund: Volume I. Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response. U.S. Environmental Protection Agency, Washington, D.C. EPA 540/1-89/002.

USEPA. 1990. National Oil and Hazardous Substances Pollution Contingency Plan. Final Rule. 55FR8666. March 8.

USEPA. 1992. Guidelines for exposure assessment. Federal register notice, vol. 57, no. 104, pp. 22888-22938. US Environmental Protection Agency, Washington, DC.

USEPA, 1993. Wildlife Exposure Factors Handbook. Vols. I and II. U.S. Environmental Protection Agency, Office of Research and Development; Washington, D.C. EPA/600-R/R-93/187a,187b.

USEPA, 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (Interim Final). U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response. EPA 540/R-97/006. June 1997.

USEPA, 1998. Guidelines for Ecological Risk Assessment. Risk Assessment Forum. U.S. Environmental Protection Agency; Washington, D.C. EPA/630/R-95/002F. April 1998.

USEPA. 2001a. Method for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analysis: Technical Manual. US Environmental Protection Agency, Office of Water. EPA-823-B-01-002. October 2001.

USEPA, 2001b. The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments. ECO UPDATE. Interim Bulletin Number 12. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.

USEPA. 2002a. Guidance for comparing background and chemical concentrations in soil for CERCLA sites. EPA 540-R-01-003. OSWER 9285.8-41. Office of Emergency and Remedial Response, US Environmental Protection Agency, Washington, DC.

USEPA. 2002b. Role of background in the CERCLA cleanup program. OSWER 9285.6-07P. Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, US Environmental Protection Agency, Washington, DC.

USEPA. 2002c. Calculating upper confidence limits for exposure point concentrations at hazardous waste sites. Office of Emergency and Remedial Response, US Environmental Protection Agency, Washington, DC.

USEPA. 2002d. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24. Office of Solid Waste and Emergency Response, US Environmental Protection Agency, Washington, DC.

USEPA. 2003. Human Health Toxicity Values in Superfund Risk Assessments. Office of Superfund Remediation and Technology Innovation. OSWER Directive 9285.8-53. December 5, 2003.

USEPA. 2004. Risk assessment guidance for Superfund: volume 1—Human health evaluation manual (Part E, supplemental guidance for dermal risk assessment). Final, July 2004. EPA/540/R/99/005. Office of Emergency and Remedial Response, US Environmental Protection Agency, Washington, DC.

USEPA, 2005. Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Metals Mixtures (Cadmium, Copper, Lead, Nickel, Silver and Zinc). EPA/600/R-02/011. January 2005.

USEPA. 2010. Explanation of PAH benchmark calculations using EPA PAH ESB approach, Originally developed by Dave Mount, ORD Duluth. June 23. November. Office of Research and Development. EPA-600-R-02-013.

USEPA. 2011. Exposure Factors Handbook: 2011 edition. EPA/600/R-09-052F. National Center for Environmental Assessment, US Environmental Protection Agency, Washington, DC.

USEPA. 2012. Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil. OSWER Directive 9200.1-113. USEPA, December 2012.

USEPA. 2013. ProUCL Version 5.0.00. Statistical software for environmental applications for data sets with and without nondetect observations [online]. Technical Support Center for Monitoring and Site Characterization, US Environmental Protection Agency. Updated September 19, 2013. Available from: [http://www.epa.gov/osp/hstl/tsc/software.htm].

USEPA. 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120. Assessment and Remediation Division, Office of Superfund Remediation and Technology Innovation, US Environmental Protection Agency, Washington, DC. February 6, 2014. With corrections through September 2015.

USEPA. 2015a. Regional Screening Level (RSL) Master Table, November 2015 [online]. US Environmental Protection Agency. Available from: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm.

USEPA. 2015b. Determination of the Biologically Relevant Sampling Depth for Terrestrial and Aquatic Ecological Risk Assessments (Final Report). U.S. Environmental Protection Agency, Ecological Risk Assessment Support Center, Cincinnati, OH, EPA/600/R-15/176. October, 2015.

Tables

Table 2-1
Values Used for Daily Intake Calculations - Soi
Benning Road Facility RI/FS Project
3400 Benning Rd, N.E., Washington DC 20019

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium/Point:	Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Unit	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Chronic Daily Intake (CDI) Equation
Incidental Ingestion	Future Recreational Visitor	Older Child/Teen (7 to <19 years)	Surface Soil	CS	Concentration in soil	mg/kg	--	--	--	--	CDI (mg/kg-day) = CS x SIR x FI x ABS x EF x ED x CF / BW x AT
				SIR	Ingestion Rate of soil	mg/day	100	USEPA, 2014	50	USEPA, 2011 (Table 5-1, central)	
				FI	Fraction Ingested	dimensionless	0.5	(a)	0.5	(a)	
				ABS	Absorption Factor	dimensionless	--	--	--	--	
				EF	Exposure Frequency	days/year	26	1 day/week from May to October	13	1 day every other week from May to October	
				ED	Exposure Duratior	years	12	receptor age range	6	1/2 RME	
				CF	Conversion Factor	kg/mg	1.00E-06	1 kg = 1E6 mg	1.00E-06	1 kg = 1E6 mg	
				BW	Body Weight	kg	53	Fryar et al. 2012	53	Fryar et al. 2012	
				AT-C	Averaging Time (Cancer)	days	25,550	70 years times 365 days per year (USEPA, 2014)	25,550	70 years times 365 days per year (USEPA, 2014)	
				AT-N	Averaging Time (Noncancer)	days	4,380	ED (years) x 365 days/year (USEPA, 2014)	2,190	ED (years) x 365 days/year (USEPA, 2014)	
				IF-C	Intake factor, cancer	(kg-sed)/(kg-bw/d)	1.15E-08	IF-C x CS x ABS = CDI-C	1.44E-09	IF-C x CS x ABS = CDI-C	
				IF-NC	Intake factor, noncancer	(kg-sed)/(kg-bw/d)	6.72E-08	IF-NC x CS x ABS = CDI-NC	1.68E-08	IF-NC x CS x ABS = CDI-NC	
	Future Outdoor Industrial Worker	Adult	Surface Soil	CS	Concentration in soil	mg/kg	--	--	--	--	CDI (mg/kg-day) = CS x SIR x FI x ABS x EF x ED x CF / BW x AT
				SIR	Ingestion Rate of soil	mg/day	100	USEPA, 2014	50	USEPA, 2011 (Table 5-1, central)	
				FI	Fraction Ingested	dimensionless	1	Assumes 100%	1	Assumes 100%	
				ABS	Absorption Factor	dimensionless	--	--	--	--	
				EF	Exposure Frequency	days/year	225	USEPA, 2014	219	USEPA, 2004, Exhibit 3-5	
				ED	Exposure Duration	years	25	USEPA, 2014	6.6	USEPA, 2011 (Table 16-82, median tenure at same job, all workers)	
				CF	Conversion Factor	kg/mg	1.00E-06	1 kg = 1E6 mg	1.00E-06	1 kg = 1E6 mg	
				BW	Body Weight	kg	80	USEPA, 2014	80	USEPA, 2014	
				AT-C	Averaging Time (Cancer)	days	25,550	70 years times 365 days per year (USEPA, 2014)	25,550	70 years times 365 days per year (USEPA, 2014)	
				AT-N	Averaging Time (Noncancer)	days	9,125	ED (years) x 365 days/year (USEPA, 2014)	2,409	ED (years) x 365 days/year (USEPA, 2014)	
				IF-C	Intake factor, cancer	(kg-sed)/(kg-bw/d)	2.75E-07	IF-C x CS x ABS = CDI-C	3.54E-08	IF-C x CS x ABS = CDI-C	
				IF-NC	Intake factor, noncancer	(kg-sed)/(kg-bw/d)	7.71E-07	IF-NC x CS x ABS = CDI-NC	3.75E-07	IF-NC x CS x ABS = CDI-NC	
	Current/Future Construction Worker	Adult	Soil	CS	Concentration in soil	mg/kg	--	--	--	--	CDI (mg/kg-day) = CS x SIR x FI x ABS x EF x ED x CF / BW x AT
				SIR	Ingestion Rate of soil	mg/day	330	USEPA, 2002	330	USEPA, 2002	
				FI	Fraction Ingested	dimensionless	1	Assumes 100%	1	Assumes 100%	
				ABS	Absorption Factor	dimensionless	--	--	--	--	
				EF	Exposure Frequency	days/year	40	5 days/week for 2 months	20	5 days/week for 1 month	
				ED	Exposure Duration	years	1	Assumed to occur over 1 year	1	Assumed to occur over 1 year	
				CF	Conversion Factor	kg/mg	1.00E-06	1 kg = 1E6 mg	1.00E-06	1 kg = 1E6 mg	
				BW	Body Weight	kg	80	USEPA, 2014	80	USEPA, 2014	
				AT-C	Averaging Time (Cancer)	days	25,550	70 years times 365 days per year (USEPA, 2014)	25,550	70 years times 365 days per year (USEPA, 2014)	
				AT-N	Averaging Time (Noncancer)	days	365	ED (years) x 365 days/year (USEPA, 2014)	365	ED (years) x 365 days/year (USEPA, 2014)	
				IF-C	Intake factor, cancer	(kg-sed)/(kg-bw/d)	6.46E-09	IF-C x CS x ABS = CDI-C	3.23E-09	IF-C x CS x ABS = CDI-C	
				IF-NC	Intake factor, noncancer	(kg-sed)/(kg-bw/d)	4.52E-07	IF-NC x CS x ABS = CDI-NC	2.26E-07	IF-NC x CS x ABS = CDI-NC	

Table 2-1
Values Used for Daily Intake Calculations - Soi
Benning Road Facility RI/FS Project
3400 Benning Rd, N.E., Washington DC 20019

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium/Point:	Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Unit	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Chronic Daily Intake (CDI) Equation
Dermal Contact	Future Recreational Visitor	Older Child/Teen (7 to <19 years)	Surface Soil	CS	Concentration in soil	mg/kg	--	--	--	--	CDI (mg/kg-day) = CS x FC x SA x AF x DAF x EF x ED x CF / BW x AT
				SA	Skin Surface Area Available for Contact	cm^2/day	3,950	Head, hands, forearms, and lower legs. See Table x for calculation	3,950	Head, hands, forearms, and lower legs. See Table x for calculation	
				FC	Fraction of Skin Contacted	dimensionless	1	full SA assumed/day	1	full SA assumed/day	
				AF	Adherence Factor	mg/cm^2	0.01	See Table x for calculation.	0.01	See Table x for calculation.	
				DAF	Dermal Absorption Factor	dimensionless	--	--	--	--	
				EF	Exposure Frequency	days/year	26	1 day/week from May to October	13	1 day every other week from May to October	
				ED	Exposure Duration	years	12	receptor age range	6	1/2 RME	
				CF	Conversion Factor	kg/mg	1.00E-06	1 kg = 1E6 mg	1.00E-06	1 kg = 1E6 mg	
				BW	Body Weight	kg	53	Fryar et al. 2012	53	Fryar et al. 2012	
				AT-C	Averaging Time (Cancer)	days	25,550	70 years times 365 days per year (USEPA, 2014)	25,550	70 years times 365 days per year (USEPA, 2014)	
				AT-N	Averaging Time (Noncancer)	days	4,380	ED (years) x 365 days/year (USEPA, 2014)	2,190	ED (years) x 365 days/year (USEPA, 2014)	
				IF-C	Intake factor, cancer	(kg-sed)/(kg-bw/d)	1.25E-08	IF-C x CS x ABS = CDI-C	3.12E-09	IF-C x CS x ABS = CDI-C	
				IF-NC	Intake factor, noncancer	(kg-sed)/(kg-bw/d)	7.29E-08	IF-NC x CS x ABS = CDI-NC	3.64E-08	IF-NC x CS x ABS = CDI-NC	
	Future Outdoor Industrial Worker	Adult	Surface Soil	CS	Concentration in soil	mg/kg	--	--	--	--	CDI (mg/kg-day) = CS x FC x SA x AF x DAF x EF x ED x CF / BW x AT
				SA	Skin Surface Area Available for Contact	cm^2/day	3,527	USEPA, 2014 Head, hands, forearms.	3,527	USEPA, 2014 Head, hands, forearms.	
				FC	Fraction of Skin Contacted	dimensionless	1	full SA assumed/day	1	full SA assumed/day	
				AF	Adherence Factor	mg/cm^2	0.12	USEPA, 2014	0.12	USEPA, 2014	
				DAF	Dermal Absorption Factor	dimensionless	--	--	--	--	
				EF	Exposure Frequency	days/year	225	USEPA, 2014	219	USEPA, 2004, Exhibit 3-5	
				ED	Exposure Duration	years	25	USEPA, 2014	6.6	USEPA, 2011 (Table 16-82, median tenure at same job, all workers)	
				CF	Conversion Factor	kg/mg	1.00E-06	1 kg = 1E6 mg	1.00E-06	1 kg = 1E6 mg	
				BW	Body Weight	kg	80	USEPA, 2014	80	USEPA, 2014	
				AT-C	Averaging Time (Cancer)	days	25,550	70 years times 365 days per year (USEPA, 2014)	25,550	70 years times 365 days per year (USEPA, 2014)	
				AT-N	Averaging Time (Noncancer)	days	9,125	ED (years) x 365 days/year (USEPA, 2014)	2,409	ED (years) x 365 days/year (USEPA, 2014)	
				IF-C	Intake factor, cancer	(kg-sed)/(kg-bw/d)	1.16E-06	IF-C x CS x ABS = CDI-C	2.99E-07	IF-C x CS x ABS = CDI-C	
				IF-NC	Intake factor, noncancer	(kg-sed)/(kg-bw/d)	3.26E-06	IF-NC x CS x ABS = CDI-NC	3.17E-06	IF-NC x CS x ABS = CDI-NC	
	Current/Future Construction Worker	Adult	Soil	CS	Concentration in soil	mg/kg	--	--	--	--	CDI (mg/kg-day) = CS x FC x SA x AF x DAF x EF x ED x CF / BW x AT
				SA	Skin Surface Area Available for Contact	cm^2/day	3,527	USEPA, 2014 Head, hands, forearms.	3,527	USEPA, 2014 Head, hands, forearms.	
				FC	Fraction of Skin Contacted	dimensionless	1	full SA assumed/day	1	full SA assumed/day	
				AF	Adherence Factor	mg/cm^2	0.3	USEPA, 2002	0.3	USEPA, 2002	
				DAF	Dermal Absorption Factor	dimensionless	--	--	--	--	
				EF	Exposure Frequency	days/year	40	5 days/week for 2 months	20	5 days/week for 1 month	
				ED	Exposure Duration	years	1	Assumed to occur over 1 year	1	Assumed to occur over 1 year	
				CF	Conversion Factor	kg/mg	1.00E-06	1 kg = 1E6 mg	1.00E-06	1 kg = 1E6 mg	
				BW	Body Weight	kg	80	USEPA, 2014	80	USEPA, 2014	
				AT-C	Averaging Time (Cancer)	days	25,550	70 years times 365 days per year (USEPA, 2014)	25,550	70 years times 365 days per year (USEPA, 2014)	
				AT-N	Averaging Time (Noncancer)	days	365	ED (years) x 365 days/year (USEPA, 2014)	365	ED (years) x 365 days/year (USEPA, 2014)	
				IF-C	Intake factor, cancer	(kg-sed)/(kg-bw/d)	2.07E-08	IF-C x CS x ABS = CDI-C	1.04E-08	IF-C x CS x ABS = CDI-C	
				IF-NC	Intake factor, noncancer	(kg-sed)/(kg-bw/d)	1.45E-06	IF-NC x CS x ABS = CDI-NC	7.25E-07	IF-NC x CS x ABS = CDI-NC	

Table 2-1
Values Used for Daily Intake Calculations - Soi
Benning Road Facility RI/FS Project
3400 Benning Rd, N.E., Washington DC 20019

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium/Point:	Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Unit	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Chronic Daily Intake (CDI) Equation
Inhalation	Future Recreational Visitor	Older Child/Teen (7 to <19 years)	Outdoor Air	CS	Chemical Concentration in So	mg/kg	--	--			
				CA	Chemical Concentration in Air	mg/m^3	--	--			Exposure Concentration (EC) (mg/m^3) =
				ET	Exposure Time	hrs/day	2	Assumes visit is short in duratior	1	1/2 RME	CA x ET x EF x ED x 1/AT
				EF	Exposure Frequency	days/year	26	1 day/week from May to October	13	1 day every other week from May to October	where:
				ED	Exposure Duratior	years	12	receptor age range	6	1/2 RME	CA = CS / (VF or PEF)
				VF	Volatilization Factor	m^3/kg	--	--	--	--	
				PEF	Particulate Emission Factor	m^3/kg	--	--	--	--	
				AT-C	Averaging Time (Cancer)	hrs	613,200	70-year lifetime x 365 days/year x 24 hrs/day	613,200	70-year lifetime x 365 days/year x 24 hrs/day	
				AT-N	Averaging Time (Noncancer)	hrs	105,120	ED (year) x 365 days/year x 24 hrs/day	52,560	ED (year) x 365 days/year x 24 hrs/day	
	Future Outdoor Industrial Worker	Adult	Outdoor Air	CS	Chemical Concentration in So	mg/kg	--	--	--	--	
				CA	Chemical Concentration in Air	mg/m^3	--	--	--	--	Exposure Concentration (EC) (mg/m^3) =
				ET	Exposure Time	hrs/day	8	USEPA, 2014	8	USEPA, 2014	CA x ET x EF x ED x 1/AT
				EF	Exposure Frequency	days/year	225	USEPA, 2014	219	USEPA, 2004, Exhibit 3-5	where:
				ED	Exposure Duration	years	25	USEPA, 2014	6.6	USEPA, 2011 (Table 16-82, median tenure at same job, all workers)	CA = CS / (VF or PEF)
				VF	Volatilization Factor	m^3/kg	--	--	--	--	
				PEF	Particulate Emission Factor	m^3/kg	--	--	--	--	
				AT-C	Averaging Time (Cancer)	hrs	613,200	70-year lifetime x 365 days/year x 24 hrs/day	613,200	70-year lifetime x 365 days/year x 24 hrs/day	
				AT-N	Averaging Time (Noncancer)	hrs	219,000	ED (year) x 365 days/year x 24 hrs/day	57,816	ED (year) x 365 days/year x 24 hrs/day	
	Current/Future Construction Worker	Adult	Outdoor Air	CS	Chemical Concentration in So	mg/kg	--	--	--	--	
				CA	Chemical Concentration in Air	mg/m^3	--	--	--	--	Exposure Concentration (EC) (mg/m^3) =
				ET	Exposure Time	hrs/day	8	USEPA, 2014	8	USEPA, 2014	CA x ET x EF x ED x 1/AT
				EF	Exposure Frequency	days/year	40	5 days/week for 2 months	20	5 days/week for 1 month	where:
				ED	Exposure Duratior	years	1	Assumed to occur over 1 year	1	Assumed to occur over 1 year	CA = CS / (VF or PEF)
				VF	Volatilization Factor	m^3/kg	--	--	--	--	
				PEF	Particulate Emission Factor	m^3/kg	--	--	--	--	
				AT-C	Averaging Time (Cancer)	hrs	613,200	70-year lifetime x 365 days/year x 24 hrs/day	613,200	70-year lifetime x 365 days/year x 24 hrs/day	
				AT-N	Averaging Time (Noncancer)	hrs	8,760	ED (year) x 365 days/year x 24 hrs/day	8,760	ED (year) x 365 days/year x 24 hrs/day	

Notes:

RME = Reasonable Maximum Exposure; CTE = Central Tendency Exposur
-- Chemical-specific value
(a) On days when the receptor is assumed to have direct contact with Site soil, one-half of the receptor's total daily ingestion exposure to outdoor soil is assumed to come from the Site and the other half while away from the Site (i.e., at home, work, school)

Sources:

Fryar, C.D., Q. Gu, and C.L. Ogden. 2012. Anthropometric reference data for children and adults: United States, 2007-2010. National Center for Health Statistics. Vital Health Stat 11(252)
USEPA, 2002d. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24. Decembe
USEPA, 2004. Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment Final. EPA/540/R/99/0
USEPA, 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-09/052F. Office of Research and Development, Washington, DC. Septembe
USEPA, 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120. Assessment and Remediation Division, Office of Superfund Remediation and Technology Inovation, US Environmental Protection Age Washington, DC. February 6, 2014, with corrections through September 2015.

Table 2-2
Values Used for Daily Intake Calculations - Groundwater
Benning Road Facility RI/FS Project
3400 Benning Rd, N.E., Washington DC 20019

Scenario Timeframe:	Current/Future
Medium:	Groundwater
Exposure Medium/Point:	Excavation Trench Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Unit	RME		CTE		Chronic Daily Intake (CDI) Equation
							Value	Rationale/ Reference	Value	Rationale/ Reference	
Inhalation	Current/Future Construction Worker	Adult	Excavation Trench Air	CS	Volatile Chemical Concentration in Groundwate	mg/kg	--	--	--	--	
				CA	Chemical Concentration in Air	mg/m^3	--	--	--	--	Exposure Concentration (EC) (mg/m^3) =
				ET	Exposure Time	hrs/day	2	Time in trench expected to be limited	2	Time in trench expected to be limited	CA x ET x EF x ED x 1/AT
				EF	Exposure Frequency	days/year	40	5 days/week for 2 months	20	5 days/week for 1 month	where:
				ED	Exposure Duration	years	1	Assumed to occur over 1 year	1	Assumed to occur over 1 year	CA = CS / (VF)
				VF	Volatilization Factor	m^3/kg	--	--	--	--	
				AT-C	Averaging Time (Cancer)	hrs	613,200	70-year lifetime x 365 days/year x 24 hrs/day	613,200	70-year lifetime x 365 days/year x 24 hrs/day	
				AT-N	Averaging Time (Noncancer)	hrs	8,760	ED (year) x 365 days/year x 24 hrs/day	8,760	ED (year) x 365 days/year x 24 hrs/day	

Notes:

RME = Reasonable Maximum Exposure; CTE = Central Tendency Exposur
-- Chemical-specific value

Table 2-3
Calculation of Body Surface Area Exposed to Soil and Adherence Factor for Older Child/Teen
Benning Road Facility RI/FS Project
3400 Benning Rd, N.E., Washington DC 20019

Older Child/Teenager (7 to <19 years, from 7th birthday to the day before 19th birthday)								
Mean Surface Area by Body Part, m^2 (EFH, Table 7-2, USEPA, 2011)								
Age	legs	lower legs (a)		head	hands	arms	forearms	
7<8 (data 6<11)	0.311	0.124	(b)	0.066	0.051	0.151	0.059	(e)
8<9 (data 6<11)	0.311	0.124	(b)	0.066	0.051	0.151	0.059	(e)
9<10 (data 6<11)	0.311	0.124	(b)	0.066	0.051	0.151	0.059	(e)
10<11 (data 6<11)	0.311	0.124	(b)	0.066	0.051	0.151	0.059	(e)
11<12 (data 11<16)	0.483	0.193	(c)	0.073	0.072	0.227	0.086	(e)
12<13 (data 11<16)	0.483	0.193	(c)	0.073	0.072	0.227	0.086	(e)
13<14 (data 11<16)	0.483	0.193	(c)	0.073	0.072	0.227	0.086	(e)
14<15 (data 11<16)	0.483	0.193	(c)	0.073	0.072	0.227	0.086	(e)
15<16 (data 11<16)	0.483	0.193	(c)	0.073	0.072	0.227	0.086	(e)
16<17 (data 16<21)	0.543	0.212	(d)	0.075	0.083	0.269	0.102	(g)
17<18 (data 16<21)	0.543	0.212	(d)	0.075	0.083	0.269	0.102	(g)
18<19 (data 16<21)	0.543	0.212	(d)	0.075	0.083	0.269	0.102	(g)
Average (cm^2)	**4,407**	**1,749**		**712**	**678**	**2,122**	**811**	
Head, hands,forearms, and lower legs	**3,950**	**Older Child/Teen**						

Body Part	**Older Child/Teenager (7 to <19 years)** **Body Surface Area (see above) (cm^2)**	**Soil Loading Rate Soccer Players No. 1 (h) (mg/cm^2)**	**Total Soil Mass (mg)**
Head	712	0.012	9
Hands	678	0.108	73
Forearms	811	0.011	9
Lower Legs	1,749	0.031	54
Total	3,950	–	54
Area-Weighted Adherence Factor (mg/cm^2) = Soil mass/Surface area =			**0.01**

Notes:
EFH - 2011 Edition of the Exposure Factors Handbook (USEPA, 2011).
(a) Lower leg surface area = leg surface area x average of the ratios of the lower leg to the leg (EFH Table 7-8), average of male and female, consistent with methods used in USEPA, 2014.
(b) Ratios of the lower leg to the leg for the 6, 8 and 10 year-olds (0.4) (Table 7-8).
(c) Ratio of the lower leg to the leg for the 12 and 14 year-olds (0.4) (Table 7-8).
(d) Ratios of the lower leg to the leg for the 16 and 18 year-olds (0.39) (Table 7-8).
(e) Surface area for the arm x average of the ratios of the forearm to the arm for 6, 8 and 10 year-olds (0.39) (EFH Table 7-8).
(f) Surface area for the arm x average of the ratios of the forearm to the arm for 12 and 14 year-olds (0.38) (EFH Table 7-8).
(g) Surface area for the arm x average of the ratios of the forearm to the arm for 16 and 18 year-olds (0.38) (EFH Table 7-8).
(h) Data from USEPA (2004; Exhibit C-2, 2011; Table 7-4). Geometric mean of soccer kids number 1 (ages 13 and 14; soccer players number 2 and 3 are adults).

Table 2-4
Calculation of Body Weights for Older Child/Teen
Benning Road Facility RI/FS Project
3400 Benning Rd, N.E., Washington DC 20019

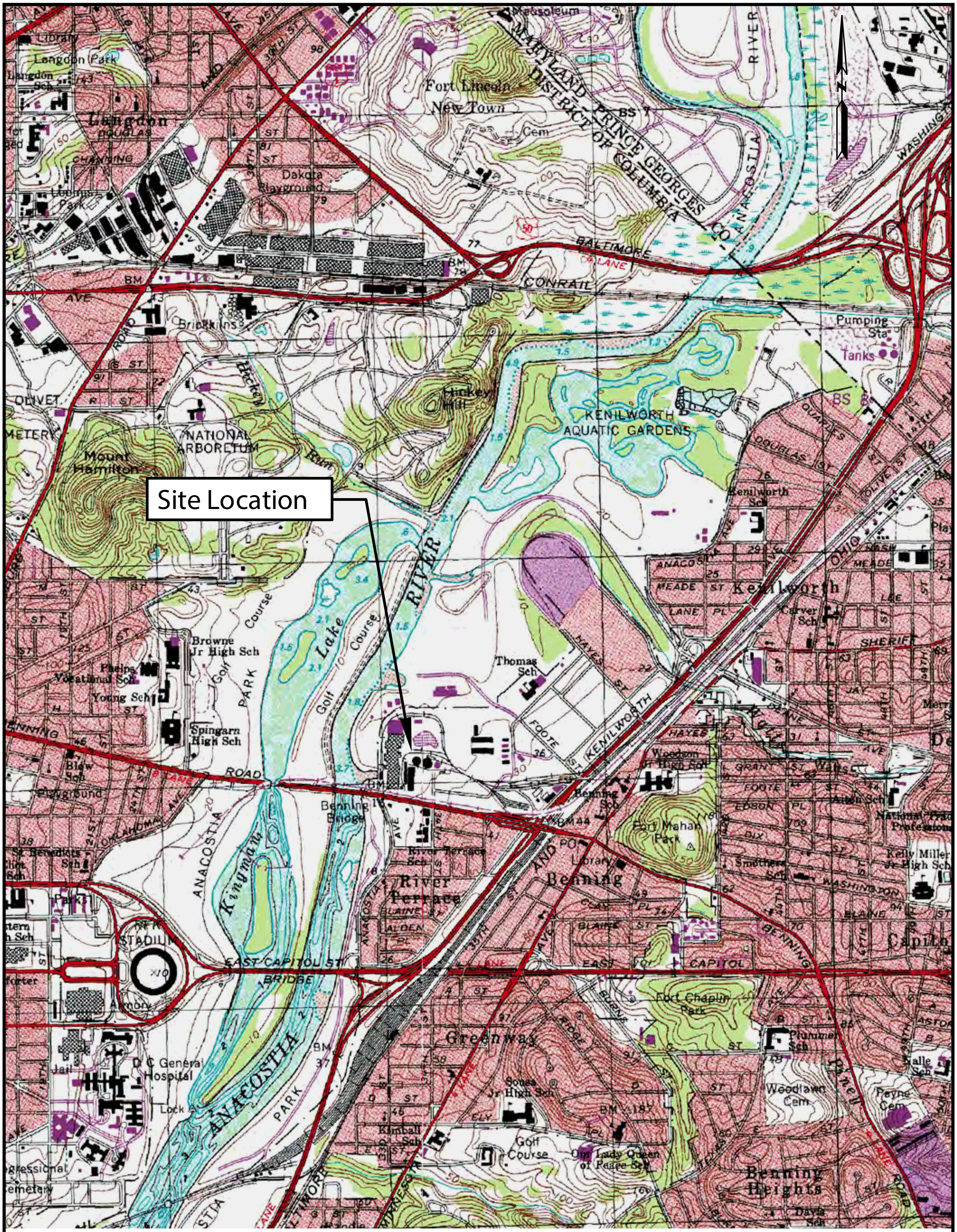
Age	Body Weight (kilograms)
7<8	26.8
8<9	31.6
9<10	36.1
10<11	40.6
11<12	47.1
12<13	51.9
13<14	58
14<15	62.8
15<16	66.7
16<17	68.8
17<18	70.6
18<19	73.4
Average Older Child/Teen (7 to <19 years)	**53**

Source:
Fryar, C.D., Q. Gu, and C.L. Ogden. 2012. Anthropometric reference data for children and adults: United States, 2007-2010. National Center for Health Statistics. Vital Health Stat 11(252).

Table 3-1
Data Collection Activities To Be Conducted in Support of the BERA

Activity	Description	Sampling Locations
Sediment Profile Imaging (SPI) data collection	Reconnaissance survey to help identify the actual depth of the bioactive zone (BAZ) in this portion of the Anacostia River	10-15 sediment sampling locations in the Waterside Investigation Area and up to five reference locations upstream of the Waterside Investigation Area
Sampling and analysis of Anacostia River sediments	Collection of discrete surficial sediment samples (0 to 6 inches [0 to 15 cm] below river bottom, unless the SPI survey dictates an alternative sampling depth) for synoptic (in time and space) evaluation of benthic macroinvertebrate community heath, sediment chemistry (bulk sediment and pore water), and sediment toxicity	
Interstitial porewater sampling	Collection of porewater samples to provide a better delineation of potentially bioavailable constituents in surficial sediments. Porewater sampling will be conducted synoptically with bulk sediment chemistry, macroinvertebrate community, and benthic toxicity testing sampling stations in order to support the BERA analyses.	
Benthic macroinvertebrate surveys	Taxonomic identification of macroinvertebrates in bulk sediment to provide a measurement endpoint for evaluating the *in situ* response of the benthic community to potential stressors in the system.	
Laboratory toxicity testing	Sediment bioassay tests to evaluate whether direct exposures to sediments have the potential to cause toxicity to ecological receptors.	

Figures



AECOM

Source:
USGS 7.5 Minute Topographic Map
Washington East Quadrangle

0 1000 2000 4000
SCALE IN FEET

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

Site Location Map

DATE: 09/16/2016	DRAWN BY: LAD	CHECKED BY: RD	FIGURE 1-1

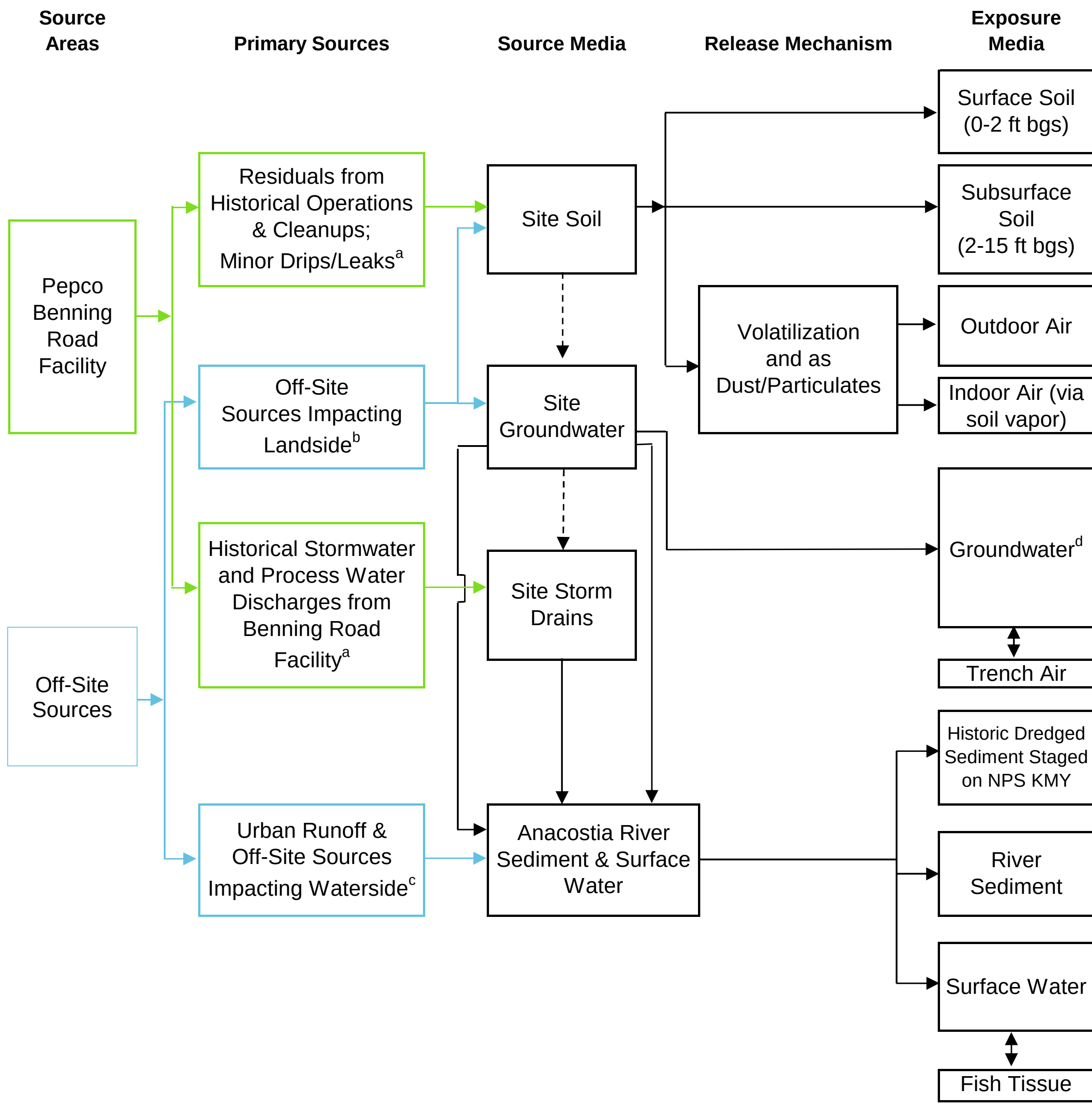
\\usch1fp001\Data\Projects\Jobs\Indl_Service\Project Files\Pepco Benning Road RI_FS\GIS\MXD\2016\SitePlanAndInvestigationArea

AECOM

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

Site Plan
And Investigation Areas

DATE: **09/16/2016** | DRAWN BY: KNS | FIGURE 1-2



Exposure Media	Potential Exposure Route	LANDSIDE: Current On-Site Worker	LANDSIDE: Current/ Future Construction Worker	LANDSIDE: Current/ Future Recreational Visitor	LANDSIDE: Future On-site Worker	WATERSIDE: Current/ Future Swimmer	WATERSIDE: Current/ Future Wader	WATERSIDE: Current/ Future Angler	WATERSIDE: Current/ Future Shoreline Worker
Surface Soil (0-2 ft bgs)	Incidental Ingestion	o	◉	◉	◉	--	--	--	--
	Dermal Contact	o	◉	◉	◉	--	--	--	--
Subsurface Soil (2-15 ft bgs)	Incidental Ingestion	o	◉	o	o	--	--	--	--
	Dermal Contact	o	◉	o	o	--	--	--	--
Outdoor Air	Inhalation	o	◉	o	o	--	--	--	--
Indoor Air (via soil vapor)	Inhalation	o	o	o	o	--	--	--	--
Groundwater[d]	Ingestion as Drinking Water	o	o	o	o	--	--	--	--
	Dermal Contact	o	o	o	o	--	--	--	--
	Incidental Ingestion	o	o	o	o	--	--	--	--
Trench Air	Inhalation	o	◉	o	o	--	--	--	--
Historic Dredged Sediment Staged on NPS KMY	Incidental Ingestion	--	--	●	--	--	--	--	--
	Dermal Contact	--	--	●	--	--	--	--	--
River Sediment	Incidental Ingestion	--	--	--	--	●	●	●	●
	Dermal Contact	--	--	--	--	●	●	●	●
Surface Water	Incidental Ingestion	--	--	--	--	●	●	●	●
	Dermal Contact	--	--	--	--	●	●	●	●
Fish Tissue	Ingestion	--	--	--	--	o	o	●	o

LANDSIDE and WATERSIDE: Potential Human Receptors/Exposure Pathways

Notes:

bgs - Below ground surface.

[a] Onsite potential primary sources to site soil and site storm drains include former sludge dewatering/coal pile area, former cooling towers, former ASTs/USTs, historical operations involving oil-fill electrical equipment, historical cleanup areas, diffuse leaks/drips, industrial runoff, and/or historical process water discharges.

[b] Offsite potential primary sources to site soil via atmospheric deposition include regional transportation and fossil fuel burning, historical open burning, and former trash incinerator.
Offsite potential primary sources to site groundwater include former dry cleaners and/or urban runoff/combined sewer overflow.

[c] Offsite potential primary sources to the river sediment and surface water include urban runoff/combined sewer overflow, Langston Golf Course/Kenilworth Landfill, and/or historical industrial discharges.

[d] Includes site groundwater and NPS Kenilworth Maintenance Yard (KMY) groundwater.

Legend

——▶	Potentially complete migration pathway.
- - -▶	Unconfirmed migration pathway.
◉	Exposure Pathway incomplete based on currently available information; pathway will be revisited following completion of the additional field investigation.
--	Not Applicable.
●	Potentially complete exposure pathway.
o	Exposure Pathway considered to be incomplete or insignificant.

AECOM

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

DATE: 9/16/16
DRAWN BY: LDB
CHECKED BY: BR

Conceptual Site Model
Human Health Risk Assessment

FIGURE 2-1

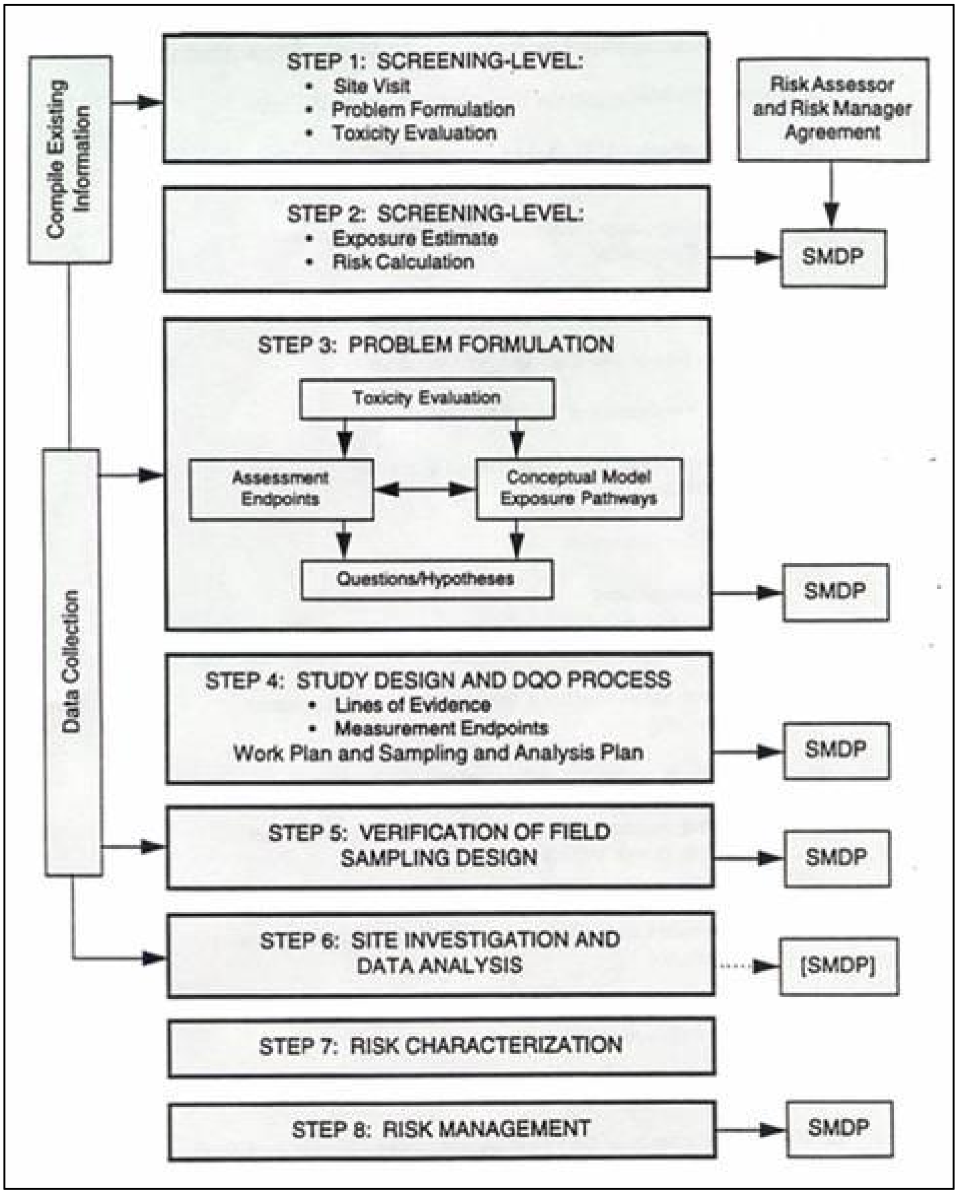
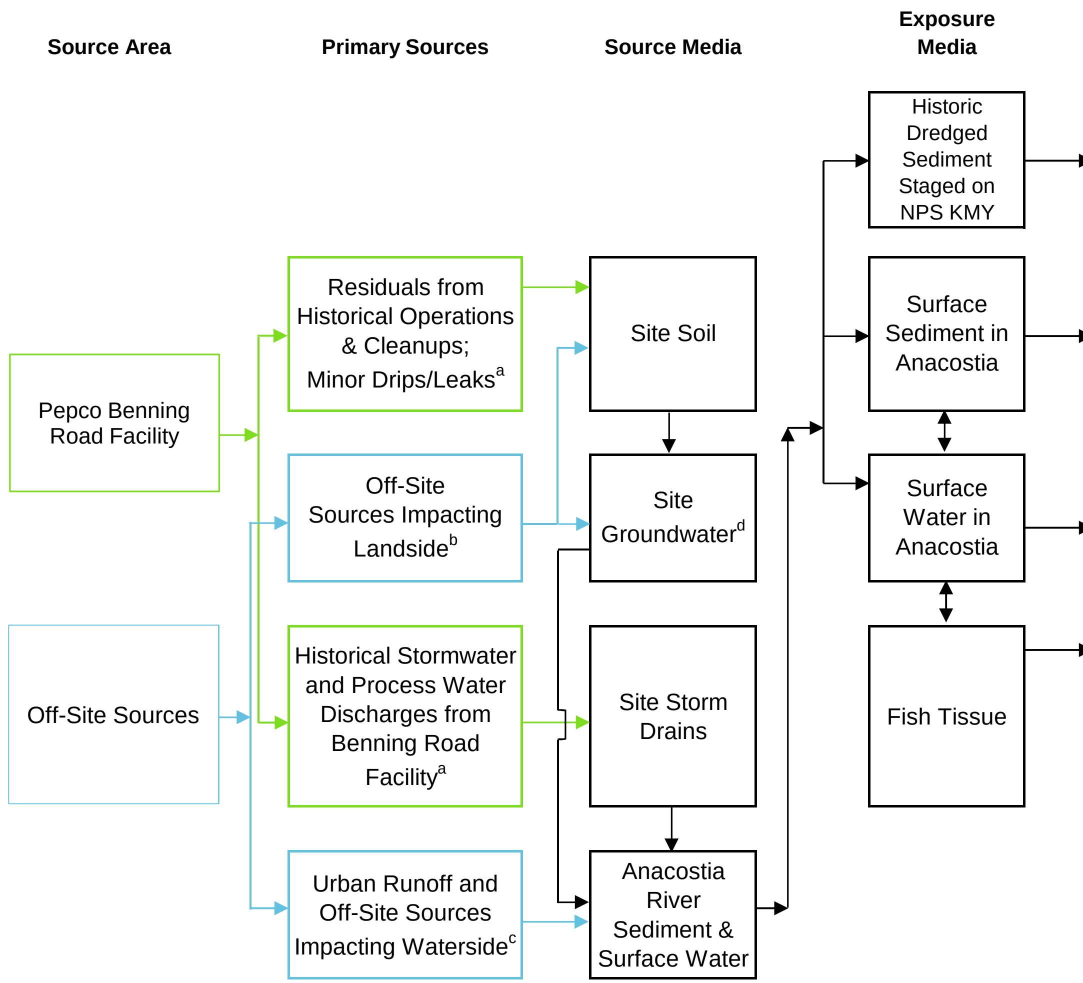


Figure 3-1. Eight Step Process for Ecological Risk Assessment
Source: USEPA, 1997



Exposure Media	Potential Exposure Route	Potential Ecological Receptors/Exposure Pathways: Benthic Invertebrate Community	Fish Community	Avian and Mammalian Communities
Historic Dredged Sediment Staged on NPS KMY	Incidental Ingestion	o	o	o
	Dermal/Direct Contact	o	o	o
Surface Sediment in Anacostia	Incidental Ingestion	●	●	●
	Dermal/Direct Contact	●	●	o
Surface Water in Anacostia	Incidental Ingestion	●	●	●
	Dermal/Direct Contact	●	●	o
Fish Tissue	Ingestion	o	o	●

[a] Onsite potential primary sources to site soil and site storm drains include former sludge dewatering/coal pile area, former cooling towers, former ASTs/USTs, historical operations involving oil-fill electrical equipment, historical cleanup areas, diffuse leaks/drips, industrial runoff, and/or historical process water discharges.

[b] Offsite potential primary sources to site soil and/or groundwater include regional transportation and fossil fuel burning, historical open burning, former trash incinerator, former dry cleaners and/or urban runoff/combined sewer overflow.

[c] Offsite potential primary sources to the river sediment and surface water include urban runoff/combined sewer overflow, Langston Golf Course/Kenilworth Landfill, and/or historical industrial discharges.

[d] Includes site groundwater and NPS Kenilworth Maintenance Yard (KMY) groundwater.

Notes
- ● Potentially complete pathway.
- o Pathway considered to be incomplete or insignificant.
- → Potential release mechanism.

AECOM

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

Conceptual Site Model of Waterside Investigation Area Ecological Risk Assessment

DATE: 9/16/16 | DRAWN BY: LDB | CHECKED BY: MW

FIGURE 3-2

M15002-a