SAMPLING AND ANALYSIS PLAN

PART I – FIELD SAMPLING PLAN

PART II – QUALITY ASSURANCE PROJECT PLAN

BENNING ROAD FACILITY

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Part I
Field Sampling Plan

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1 Site Background

This Field Sampling Plan (FSP) is prepared to supplement the Remedial Investigation and Feasibility Study (RI/FS) Work Plan to describe the field sampling approach for the RI/FS at Pepco's Benning Road facility (the Site), located at 3400 Benning Road NE, Washington, D.C., and a segment of the Anacostia River adjacent to the Site. The general site location is shown on **Figure 1**. Together, the Site and the adjacent segment of the River are referred to herein as the "Study Area". The RI/FS Study Area consists of a "landside" component which will focus on the Site itself, and a "waterside" component that will focus on the shoreline and sediments in the segment of the river adjacent to and immediately downstream of the Site. The landside and waterside areas of investigation are depicted in **Figure 2**. Pepco has agreed to perform the RI/FS pursuant to a consent decree that was entered by the U.S. District Court for the District of Columbia on December 1, 2011 (the Consent Decree). The Consent Decree documents an agreement between Pepco and the District of Columbia (District) which is part of the District's larger effort to address contamination in and along the lower Anacostia River.

The Site is one of several properties along the Anacostia River that are suspected sources of contamination. There have been ~~five~~ six* instances since 1985 in which materials containing polychlorinated biphenyls (PCBs) were released at the Site. In each case, Pepco promptly cleaned up the releases in accordance with applicable legal requirements. Nonetheless, it is suspected that these releases, and possibly other historical operations or activities at the Site, may have contributed to contamination in the river. In particular, a site inspection conducted for the U.S. Environmental Protection Agency (USEPA) in 2009 linked polycyclic aromatic hydrocarbons (PAH), PCBs, and inorganic constituents detected in Anacostia River sediments to potential historical discharges from the Site. The site inspection contractor also stated that currently the Site is properly managed and that any spills or leaks of hazardous substances are quickly addressed and, if necessary, properly remediated. The RI will evaluate all spills at the Site as necessary.

The purpose of the RI/FS is to (a) characterize environmental conditions within the Study Area, (b) investigate whether and to what extent past or current conditions at the Site have caused or contributed to contamination of the river, (c) assess current and potential risk to human health and environment posed by conditions within the Study Area, and (d) develop and evaluate potential remedial actions.

The 77-acre Site is bordered by a DC Solid Waste Transfer Station to the north, Kenilworth Maintenance Yard (owned by the National Park Service, NPS) to the northwest, the Anacostia River to the west, Benning Road to the south and residential areas to the east and south (across Benning Road). Most of the Site is comprised of the Benning Service Center, which involves activities related to construction, operation and maintenance of Pepco's electric power transmission and distribution system serving the Washington, D.C., area. The Service Center accommodates more than 700 Pepco employees responsible for maintenance and construction of Pepco's electric transmission and distribution system; system engineering; vehicle fleet maintenance and refueling; and central warehousing for materials, supplies and equipment. The Site is also the location of the Benning Road Power Plant, which is scheduled to be shut down in 2012. The Site is one of several properties along the Anacostia River that are suspected sources of contamination.

Pepco conducted several investigations and removal actions at the Site since 1985 (**Table 1** and **Figure 3**). The USEPA conducted two studies, a Multi-media Inspection and a Comprehensive Environmental Liability and Compensation Act (CERCLA) Site Inspection, within the Study Area. In addition, the NPS completed a remedial investigation at the adjacent Kenilworth Landfill and a Preliminary Assessment/Site Investigation (PA/SI) at Langston Golf Course. AECOM reviewed available information from these studies and other studies conducted in the River by various governmental and non-governmental organizations, and incorporated the findings into the Conceptual Site Model (CSM) and Work Plan development. Detailed information on previous investigations, geology, hydrogeology, hydrology, and site and area descriptions can be found in the RI/FS Work Plan.

The RI/FS will be overseen by the District Department of the Environment (DDOE) and will be performed in accordance with the USEPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Office of Solid Waste and Emergency Response (OWSER)* Directive 9355.3-01, dated October 1988, and other applicable USEPA and DDOE guidance documents. This FSP (Part I of the Sampling and Analysis Plan) is prepared in accordance with the outline provided in the Final RI/FS Scope of Work (SOW) and applicable USEPA guidance.

2 Sampling Objectives

The field investigation activities are designed to characterize conditions in soil, groundwater, surface water and sediment, further refine the CSM, and collect data to support risk assessment and Natural Resource Damage Assessment (NRDA). Data gaps identified during the review of existing data were used to guide the scope of this investigation. Field investigation activities are divided into Landside and Waterside activities and are noted in **Section 1**. All field investigation activities will be conducted in accordance with the RI/FS Work Plan, the Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP), submitted under a separate covers.

The data quality objectives (DQOs) for this investigation are:

- To characterize environmental conditions within the Study Area and refine the CSM
- To collect data to update existing Landside and Waterside datasets so the nature and extent of impacts can be better defined
- To collect data to determine whether and to what extent past or current conditions at the Site have caused or contributed to contamination of the Anacostia River
- To collect data within the Anacostia River to identify potential Site-related, near-Site and far-Site sources of contaminants of potential concern (COPCs) in sediment and surface water
- To collect hydraulic data to better understand the site-specific hydrogeology and evaluate the volumetric flux of groundwater to the Anacostia River
- To collect data to better understand sedimentation in the portion of the Anacostia River within the Study Area
- To collect data to support performance of Human Health and Ecological Risk Assessments
- To collect data to support development and evaluation of remedial alternatives
- To collect data for NRDA evaluation

The Landside and Waterside DQO development process is presented in **Tables 2** and **3,** respectively.

3 Sampling Location and Frequency

In order to meet the RI/FS project schedule expeditiously, the planned investigation will incorporate an iterative, dynamic approach to the investigation using field screening techniques, field-based decision-making and real-time evaluation of data while crews are still in the field, as necessary. In consultation with the DDOE and Pepco project management, the AECOM Field Team Leader will use professional judgment to adjust sampling locations, as appropriate based on field conditions. Field and laboratory data will be rapidly uploaded to the project database to allow a timely evaluation of results and thereby allow near real-time adjustments to the field investigation, as necessary, to complete the delineation of impacts encountered.

3.1 Landside Investigation

The Landside investigation program will include three phases of work, each phase providing necessary information for the planning of the successive phase of work. The Landside data collection program is summarized in **Table 2**. Phase I activities will involve sampling of surface soils and storm drains. In addition, Phase I will first involve the screening of the Site using electrical resistivity imaging (ERI) to identify potential anomalies, followed by soil borings to calibrate the electrical signals with lithologic and chemical sampling.

ERI also provides useful information on soil and groundwater zones impacted by light non-aqueous phase liquids (LNAPLs) and/or dense non-aqueous phase liquids (DNAPLs). These zones will be targeted during Phase II using the direct push technology (DPT) (Geoprobe®) borings to delineate potential zones of impact and identify any continuing sources of contamination. Additional direct push borings will be conducted during Phase II to collect soil and groundwater samples and characterize horizontal and vertical extent of any impacts found using PID and XRF field instruments, and total petroleum hydrocarbon (TPH) and PCB aroclor analysis using an on-site mobile lab. **Figure 4** depicts the proposed surface soil sample and ERI transect locations. **Figure 5** depicts the proposed sediment/residue sample locations from the storm drain system. **Figure 6** depicts the locations of the proposed soil borings.

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

To help guide all of these Landside investigation activities, AECOM identified several “Target Areas” on the Site based on historical investigations and remediation, UST closures, former and current operations that could have a potential for Site impacts. These Target Areas are depicted on **Figure 3**. It should be noted that Pepco completed investigations and/or cleanups in Target Areas with PCB and petroleum releases in accordance with the District regulations. Some target areas have been identified based on PCB handling operations, which are in compliance with applicable regulations, and current fuel storage. Therefore, the purpose for these Target Areas is to serve as a guide to steer the RI field activities. Target Areas may be grouped together during the initial phases of investigations. As investigation activities proceed in an iterative fashion, they will focus on any impacts observed in or around the Target Areas.

3.2 Waterside Investigation

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

This investigation will primarily address sediment conditions within the Waterside Investigation Area, an area of the Anacostia River approximately 10 to15 acres in size including approximately 1,500 linear feet to the south (approximately 1,000 feet south of the Benning Road Bridge) and 1,000 linear feet to the north of the Site’s main storm water outfall area (**Figure 7**). The proposed study area is based on its proximity to the Site and results from the USEPA 2009 SI Report.

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

Data for the Waterside area will be collected in two phases. Phase I will involve bathymetric and utility surveys at on-site and background locations. Surface water and sediment sampling will be conducted under Phase II.

Sediment samples will be collected using barge-mounted Vibracore™ equipment. An on-site mobile lab will be used to characterize the extent of sediment impacts using PCBs aroclor analysis.

The Waterside investigation will use a systematic sampling grid to determine sediment and surface water sampling locations during the Waterside investigation (**Figure 7**). This grid will consist of 45 sampling locations on ten (10) sampling transects positioned perpendicular to the shoreline. Three to five sampling locations will be positioned evenly spaced along each transect. Additional sampling locations will be positioned between each transect and close to Outfall 013 and two sampling locations will be placed in the wetland area for a total of 45 sampling locations within the Waterside Investigation Area. The exact locations of the sampling locations may vary according to the conditions of the substrate, the nature of depositional processes observed in the geophysical survey, and agency consultation prior to the field effort.

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

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

The data collection program for Waterside area is summarized in **Table 5**.

4 Sample Designation

Sample designation is a unique number that identifies each sample under the analytical program. Immediately upon collection, each sample will be labeled with an adhesive label. Each sample label will include the sample number, location, date/time of collection, and analysis. Each sample number will consist of a four part identification system that describes the sampling method, location ID, depth, and sample type, as described below:

- Sampling Method: This part is represented by a three letter code as follows:

Monitoring Well Soil	MWS
Monitoring Well Water	MWW
Soil Boring Soil	SBS
Soil Boring Water	SBW
Direct Push Soil	DPS

Direct Push Water	DPW
Surface Soil Sample	SUS
Sediment	SED
Surface Water	SUW

- Location: This will be a two digit code consisting of numbers, letters or a combination (e.g., 01, 15, C2).
- Sample Depth: Sample depth will be identified using a two digit number (e.g., 05 representing 5 feet below grade). Where sample depth involves an interval, this identifier identifies the starting depth of the interval only. The number "00" will represent surface samples.
- Sample Type: The last character of the sample ID will represent the sample type:
  N –Field sample
  R – Field duplicate
  Q –Quality control (QC) sample (e.g., equipment blank, trip blank)

- Equipment Blank – "EB" followed by date (e.g., EB-070110). If multiple EBs are collected on the same day for differing types of sampling equipment, numerical designations will be used to differentiate the type of equipment blank (e.g., EB01-070110, EB02-070110), with the type of sampling equipment associated with each type of equipment blank documented in the field log book (e.g., EB01-070110 collected from split spoon sampler, EB02-070110 collected from Geoprobe® cutting shoe)

- Trip Blank – “TB” followed by date (e.g., TB-070110). If multiple TBs are collected on the same day for multiple coolers of VOC samples, numerical designations will be used to differentiate the different trip blanks (e.g., TB01-070110, TB02-070110). The cooler specific chain-of-custody forms will document which VOC samples are associated with the trip blanks.

An example of a complete sample ID would be MWW0515N for the groundwater sample collected from monitoring well MW-5 at15 feet below grade. Another example would be SEDC200R representing duplicate of a surface sediment sample collected at grid node C2.

Samples being designated for matrix spike and matrix spike duplicate (MS/MSD) analysis will *not* include an identifier as part of the sample code, but will be identified as such on the chain-of-custody in the comments section on the same row as the parent sample.

5 Sampling Equipment and Procedures

5.1 Field Techniques

Field work and sampling will be conducted to evaluate impacts to the environmental media in the Study Area, as shown on **Figure 4** and **Figure 6**. Field work will include drilling of soil borings, installation of monitoring wells, groundwater measurements, and collection of soil, sediment, surface water, and groundwater samples for field screening and laboratory analyses. Sampling and data collection planned for Landside and Waterside areas are summarized in **Table 4** and **Table 5**, respectively. A summary of calibration frequency and criteria for field instruments are summarized in **Table 6**.

AECOM has developed a set of standardized Project Operating Procedures (POPs) following USEPA and other applicable standard protocols, for the proposed field sampling and data collection program. Following is a list of AECOM POPs. Copies of the POPs are provided in **Appendix A** of this FSP.

- POP 005 – Sediment Core Sampling Procedures
- POP 016 – Sealed-Screen Groundwater Profiling
- POP 028 – Standard Operating Procedure for the Niton XL3t 600 Niton XRF
- POP 101 –Field Records
- POP 102 – Chain of Custody and Shipping Procedures
- POP 103 – Packaging and Shipping
- POP 105 –Decontamination of Field Equipment
- POP 106 – Investigative Derived Waste Management
- POP 201 – Surface Water Sample Collection
- POP 202 – Sediment Sampling
- POP 301 – Subsurface Soil Sampling by Direct Push Methods
- POP 302 – Subsurface Soil Sampling by Hollow Stem Auger and Split-Spoon Sampler Methods
- POP 304 – Surface Soil Sampling
- POP 305 – Soil Sampling via Hand Auger
- POP 401 – Monitoring Well Construction and Installation

- POP 402 – Monitoring Well Development
- POP 403 – Water Level Measurement in a Monitoring Well
- POP 404 – Low-Flow Groundwater Sampling
- POP 501 – Headspace Analysis of VOCs in Unsaturated Soil Samples
- POP 502 – Water Quality Instrumentation

5.2 Landside Investigation

The phased data collection program described in **Section 3.1** and **Table 4** will be carried out as described in the following paragraphs. These field tasks will be conducted in accordance with approved Work Plan, permits, Health and Safety Plan, and Quality Assurance Project Plan, following the POPs.

The field activities proposed for the Landside investigation are as follows:

- Utility clearance;
- Surface soil sampling;
- Storm drain sampling;
- Electrical Resistivity Imaging (ERI);
- Soil borings;
- Direct Push Technology (DPT) subsurface investigation;
- Monitoring well installation
- Monitoring well gauging and sampling; and
- Aquifer testing

A summary of the data types, quantities, analytes and methodologies, and data uses is presented in **Table 4**. Permits or access agreements that may be required from the District of Columbia will be obtained prior to initiation of the field program.

The following sections describe the field activities that will be performed during the Landside investigation. All of the sampling locations proposed within the Landside Investigation Area are presented in **Figure 4**. Additional samples will be collected from the background sampling areas.

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

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

Phase I, Task 2: Surface Soil Sampling

The purpose of surface soil sampling is to evaluate surface soil quality and to help plan the DPT investigation. The analytical data will also be used to develop correlations with field instruments to be used for screening during Phase II activities. Surface soil samples will be collected from within the top 12 inches of the subsurface after coring through existing pavement or ground cover. Each sample will be screened with a field PID and XRF instrument and the results will be recorded. As shown in **Table 4**, a total of 25 surface samples will be collected from various portions of the Site. The surface soil samples locations will be distributed to get a good coverage of the entire facility, while using some biased samples to address the Target Areas presented (**Figure 3**).

Phase I, Task 3: Storm Drain Sampling

The purpose of storm drain sampling is to determine, if current or historical discharges from the storm drain system contributed to contamination in the River. Pepco proposes to re-sample the six locations sampled during the 1997 USEPA Multi-media Inspection, and in addition sample the influent and effluent sides of Outfall 013, and Outfall 101, for total of up to nine locations. Collection of residue and water samples is contingent upon availability of sampling media and access to the locations at the time of sampling. A map showing the tentative sample locations is provided as **Figure 5** and analytical particulars are presented in **Table 4**. Up to two of these locations will be selected for forensic analysis.

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

ERI techniques are commonly used in environmental site characterization and involve the measurement of electrical conductivity/resistivity of the ground. A variation of the ERI technology known as GeoTrax™ is offered by Aestus, LLC. Each GeoTrax Survey™ will be performed by installing specialized 3/8-inch diameter stainless steel electrodes into the ground along a straight line or transect that could run hundreds of feet long depending on the target depth of investigation. The electrodes are hammered into the ground just far enough to get electrical contact with the earth, typically 6 to 15 inches. The resulting data is processed using proprietary algorithms to produce a color-coded, high-resolution, 2-dimensional or 3-dimensional image that can be used to identify anomalies that represent changes in subsurface lithology, buried objects, and LNAPL/DNAPL plumes, and chlorinated compounds such as PCBs. GeoTrax™ imaging can be used as a screening tool and when calibrated with actual lithologic and chemical data collected from a direct push boring, it provides a rapid site characterization tool. Up to eight GeoTrax™ transects will be run along cross section A-A’, in the former sludge dewatering area, and other Target Areas to the top of the Arundel Clay unit as identified in **Figure 4**. Calibration borings will be performed using a combination of soil borings in Phase I and direct-push borings under Phase II.

Phase I, Task 5: Soil Borings

A geotechnical investigation will be conducted to aid in the verification of the existing data and design of monitoring wells. Five soil borings (SB-1 through SB-5) will be installed at the approximate locations shown on **Figure 6.** In addition, **Figure 6** shows the area on the NPS property where DDOE proposes to place an additional geotechnical soil boring. The placement of a boring in this area will require a permit from the National Capital Parks – East (NCPE). Further, it is Pepco's understanding that this property falls within a historical/cultural resource protection area and as such any borings placed in this area would require the State Historical Preservation Office (SHPO) clearance and potentially archeological logging. Pepco will use reasonable efforts to obtain the required permit and approvals.

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

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

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

Phase II, Task 1: DPT Subsurface Investigation

Following the completion of Phase I, DPT borings will be advanced in and around Target Areas identified on **Figure 3** as well as any anomalies identified by the ERI activities. As described in **Section 3.0**, Target Areas identified on **Figure 3** are for guidance purposes only. Several of the Target Areas that are geographically close may be grouped together and investigated as one area based on field logistics. A total of 40 DPT soil borings are planned. Soil borings will be advanced to approximately 5 feet below the first water table or refusal, whichever is encountered first. Soil cores will be screened continuously using a PID. A field geologist will continuously log the cores in accordance with the USCS to the terminal depth of the boring.

Soil samples will be collected from three depths and subjected to screening using an XRF field instrument, and total petroleum hydrocarbon (TPH) and PCB aroclor analysis using an on-site mobile laboratory. Boring locations and characterization parameters will be adjusted based on the screening data. Investigation activities will focus on any Target Areas where impacts are observed. Groundwater samples will be collected in-situ from the within the top five feet of the water table using a discrete sampling DPT tool. It should be noted that groundwater sample intervals may be adjusted based on the results of the ERI screening. Groundwater and soil samples will be submitted for laboratory analysis as noted in **Table 4**. A subset (approximately 20%) of the samples will be subjected to metals analysis for confirmation of the field XRF data.

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

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

Phase III, Task 1: Monitoring Well Installation

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

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

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

Drill cutting and development water will be managed as described in **Section 5.4** below. Top of casing elevations and locations for each groundwater monitoring well will be surveyed into existing Site datum by a licensed surveyor. In addition, one or more river gauging stations will be established in the Anacostia River and surveyed as well.

Phase III, Task 2: Monitoring Well Gauging and Sampling

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

Groundwater samples will be collected from monitoring wells with portable bladder pumps using disposable bladders and low-flow sampling techniques. Groundwater samples will be collected and analyzed as noted in **Table 4**. Disposable sampling materials, decontamination water and purge water will be containerized and managed as described in **Section 5.4** below.

Phase 3, Task 3: Aquifer Testing

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

5.3 Waterside Investigation

The phased data collection program described in **Section 3.2** and **Table 5** will be carried out as described in the following paragraphs. These field tasks will be conducted in accordance with approved Work Plan, permits, Health and Safety Plan, and Quality Assurance Project Plan, following the POPs.

The field activities proposed for the Waterside investigation are as follows:

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

A summary of the data types, quantities, analytes and methodologies, and data uses is presented in **Table 5**. Permits or access agreements that may be required from the District of Columbia, United States Coast Guard (USCG), the United States Army Corps of Engineers (USACE) and the NPS will be obtained prior to initiation of the field program.

The following sections describe the field activities that will be performed during the Waterside investigation. All of the sampling locations proposed within the Waterside Investigation Area are presented in **Figure 7**. Additional samples will be collected from the background sampling areas.

Phase I, Task 1: Bathymetric and Utility Surveys

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

A specialty subcontractor will perform the utility survey within the Waterside Investigation Area identified in **Figure 7**. A limited bathymetric survey will also be performed at background sampling locations to assure the similarity of river bottom morphology with that at the site and to confirm the lack of utility crossings at these locations. Side scan sonar and/or magnetometer surveys will be used to identify any utilities or large pieces of debris that might interfere with the proposed sampling activities.

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

Phase II, Task 1: Surface Water Sampling

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

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

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

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

Surface water samples will be analyzed for the following parameters:

- In all samples – Total and dissolved phase metals, PCB aroclors, PAH16, and hardness.

- In a sub-set of up to 10 samples – O&G, VOCs, SVOC, pesticides, dioxins/furans.

A summary of the analytes and methodologies is presented in **Table 5** and details on chemical analyses are provided in the SAP.

Phase II, Task 3: Surface Sediment Samples

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

A surface sediment grab sample will be collected at all 45 of the sampling locations shown in **Figure 7**, in addition to 10 background locations (total of 55 surface sediment samples). If obstructions such as boulders or cobbles are encountered at a specific station, the location of the station may be changed to collect sediment samples as required. In the case that boulders or debris are encountered, samples will be collected as close as possible to the specified sample location.

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

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

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

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

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

A summary of the analytes and methodologies is presented in **Table 5** and details on chemical analyses are provided in the SAP.

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

Forty-five Vibracore™ sediment borings will be completed at the sediment sampling locations shown on **Figure 7** (i.e., co-located with the surface sediment sampling locations). The sediment cores will be collected using a small boat equipped to advance a 3-inch diameter Vibracore™ sampler to a maximum depth of 10 feet below the sediment surface, or to refusal, whichever is encountered first. The ten foot target depth is based on published average sedimentation rates for the Anacostia River (approximately 4 to 6.5 cm/yr) and should provide a sediment column that includes sedimentation which generally predates the operation of the facility. A second consideration is the general limits of the Vibracore™ sampling tool which vary depending on sediment type and compaction history.

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

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

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

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

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

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

A summary of the analytes and methodologies is presented in **Table 5** and details on chemical analyses are provided in the SAP. The Waterside sampling program will include the collection of up to seven (7) sediment samples for submittal to a specialty forensics laboratory for fingerprinting purposes. Testing will be performed to identify PCBs and PAH contributors to the total PCB and PAH load identified in the samples. Testing may also include upstream (i.e., background) samples, if field observations indicate an alternative potential source of PCBs and PAHs that warrants further consideration. This forensic analysis will be used to differentiate between Benning Road sources and other potential sources of PCBs and PAHs in the Anacostia River sediments.

5.4 Investigation-Derived Waste (IDW) Management

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

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

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

5.5 Field Data Collection and Transmission

Each investigation point will be located using a global positioning system receiver with sub-two-meter accuracy. These data will be transmitted daily to the office for inclusion in the project database. Based on accessibility, exterior locations will also be surveyed in by a licensed surveyor, while locations in building interiors will be field-measured off known landmarks.

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

6 Sampling Handling and Analysis

Sample handling includes packaging and shipping samples to designated laboratories, upon completion of sample collection. The QAPP discusses the analytical parameters, methods, laboratory locations, and contacts. Field Teams are responsible for all aspects of sample handling and will communicate to the laboratories and AECOM Analytical Task Manager of any changes/deviations due to sampling problems. Potential sampling problems may include:

- Filling out paperwork incorrectly or incompletely
- Collecting less than the required sample volume
- Shipping samples to the wrong lab
- Using incorrect sample containers
- Leaking sample containers
- Equipment malfunction
- Severe weather conditions

If any of these problems occur, the Field Team must promptly report the problem to the AECOM Field Operations Manager and Project Manager, and implement necessary corrective measures as directed.

Field samples will be packed and shipped to the laboratory according to POP 103 – Packaging and Shipment of Samples (**Appendix A**). Samples will be properly packaged on ice at 4°C for shipment and dispatched to the laboratory for analysis, with a separate signed custody record enclosed in and secured to the inside top of each sample box or cooler. Shipping containers will be sealed and secured with strapping tape and custody seals for shipment to the laboratory. The custody seals will be attached to the front right and back left of the cooler and covered with clear plastic tape after being signed by field personnel. The cooler will be strapped shut with strapping tape in at least two locations.

If the samples are sent by common carrier, the waybill will be used. Waybills will be retained as part of the permanent documentation. Commercial carriers are not required to sign off on the custody forms since the custody forms will be sealed inside the sample cooler and the custody seals will remain intact.

7 Field Quality Control

7.1 Preventing Cross Contamination

Proper equipment preparation, cleaning, and field decontamination procedures are necessary to prevent cross contamination of samples. These procedures are discussed in the following paragraphs:

<u>Pre-sampling Preparation</u>

Dedicated sampling equipment will be pre-cleaned and wrapped prior to arrival on-site. Other sampling equipment will be decontaminated prior to the start of activities and between sampling locations in accordance with the specifications described below. Field personnel performing the collection procedures will don a new pair of nitrile rubber latex examination gloves prior to handling any sampling equipment, between sampling and decontamination procedures and between sampling locations.

<u>Cleaning Materials</u>

Laboratory grade glassware detergent will be a standard brand of phosphate-free detergent such as Alconox or Liquinox. Tap water will be obtained from a local municipal supply or commercial source. Distilled, analyte-free water will be used as the final water rinse.

<u>Field Decontamination Procedures</u>

Non-dedicated sampling equipment and tools will be decontaminated prior to each use by scrubbing with laboratory grade glassware detergent and tap water to remove visual contamination followed by a generous tap water rinse and a final distilled and/or deionized water rinse.

7.2 Quality Control Sampling

In addition to the sampling program presented in **Tables 4** and **5**, several QC samples will be collected to estimate precision and accuracy of the analytical results, and to examine the sources of error introduced by the field and laboratory practices.

Field Blanks

Field (rinseate) blanks are required for all phases of sampling in which non-dedicated field sampling equipment will be used. Field blanks consist of pouring de-ionized analyte-free water over decontaminated sampling equipment as a check that the decontamination procedure has been adequately carried out and that there is no cross-contamination of samples occurring due to the equipment itself. Collection of field blanks is performed for all analytes of interest. One field blank will be taken per day as needed when reusable sampling equipment is utilized in the sample collection process.

Field Duplicate Samples

A field duplicate consists of an actual sample for which twice as much volume as necessary to fill all sample containers has been collected. Aliquots of this volume are then equally distributed in two sets of sample containers. This division results in two equal samples collected from one sampling location. Field duplicates are used to assess consistency of sampling, sample homogeneity, and laboratory analytical consistency. These sample duplicates may be submitted as laboratory blind duplicates and are analyzed for all analytes of interest. Field duplicates will be collected at a minimum frequency of five percent (1 in 20) of the total number of samples collected per sample matrix.

Duplicates of sediment samples will be homogenized prior to filling appropriate sample containers. It may be necessary to co-locate or depth integrate collection so that enough volume is available for duplicate sample collection.

Trip and Temperature Blank Samples

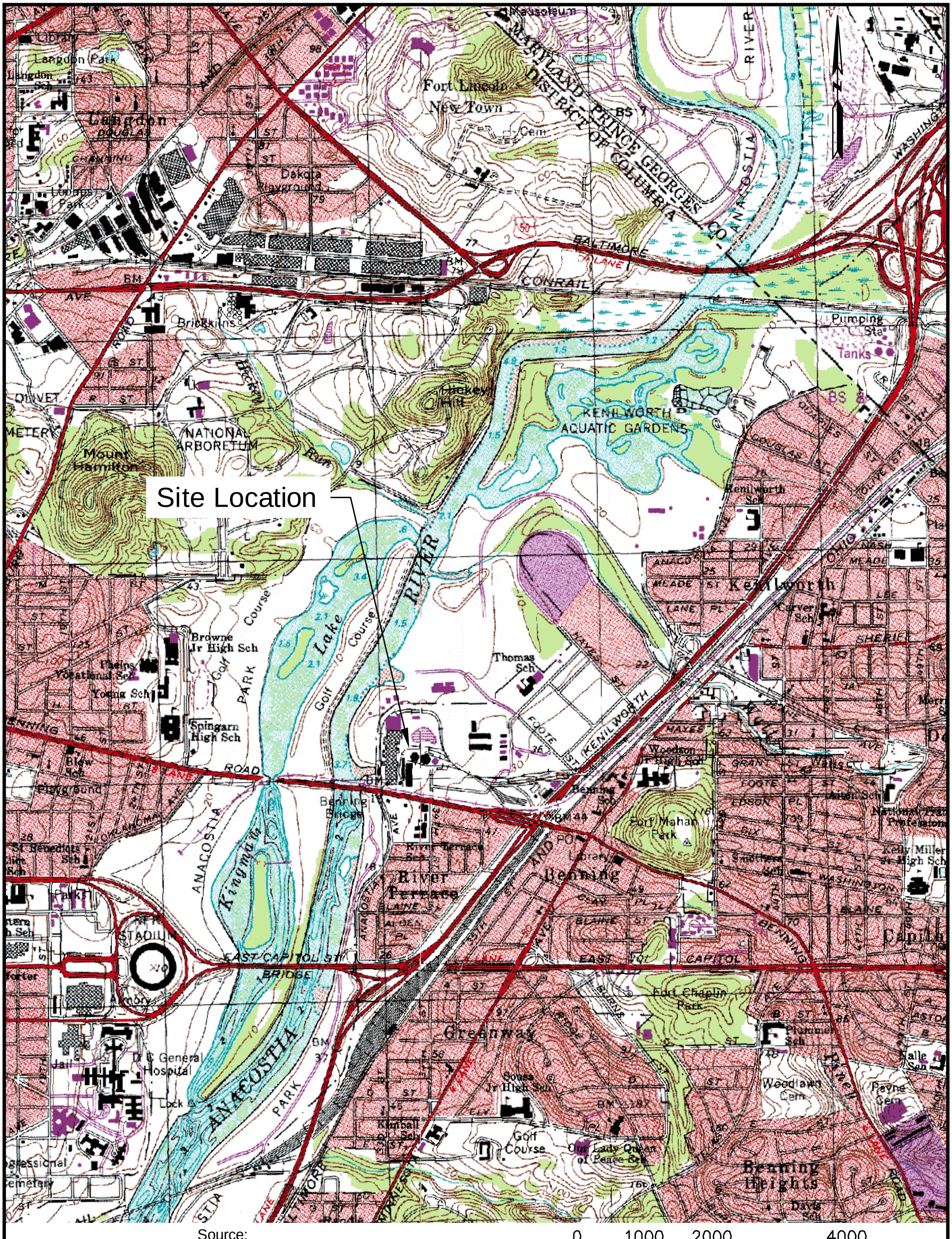
A pre-prepared trip blank and temperature blank consisting of de-ionized water will accompany each sample cooler during transport to the laboratory. These will be used as a standard to ensure that samples were maintained within laboratory specifications during shipment. Trip blanks will be collected at a frequency of one per day when VOC analysis is involved.

7.3 Sample Documentation, Custody and Shipping

A sample is physical evidence collected from the project site. Due to the evidentiary nature of the data collected, the possession of samples must be traceable from the time the empty sample containers are prepared by the container supplier through the reporting of the analytical results. When samples are to be collected for chemical or physical characteristics analysis, documentation such as sample labels and Chain of Custody (COC) forms will be completed. An example of a COC record is provided as **Figure 8**.

Each sample label will include the sample number, location, date/time of collection, and analysis. These labels will be used to assist in the tracking of samples and to facilitate retrieval of analytical results. The sample identification number will be used on sample labels and COC forms. Sample designation methodology is described in **Section 4**.

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: 06/20/2012
DRAWN BY: LAD
CHECKED BY: RD

FIGURE 1

File: P:\Environment Projects\60249055 – PEPCO – Benning Rd Facility\RI–FS\Site Plan.dwg Layout: Site plan User: weberk Plotted: Feb 27, 2013 – 1:02pm Xref's:

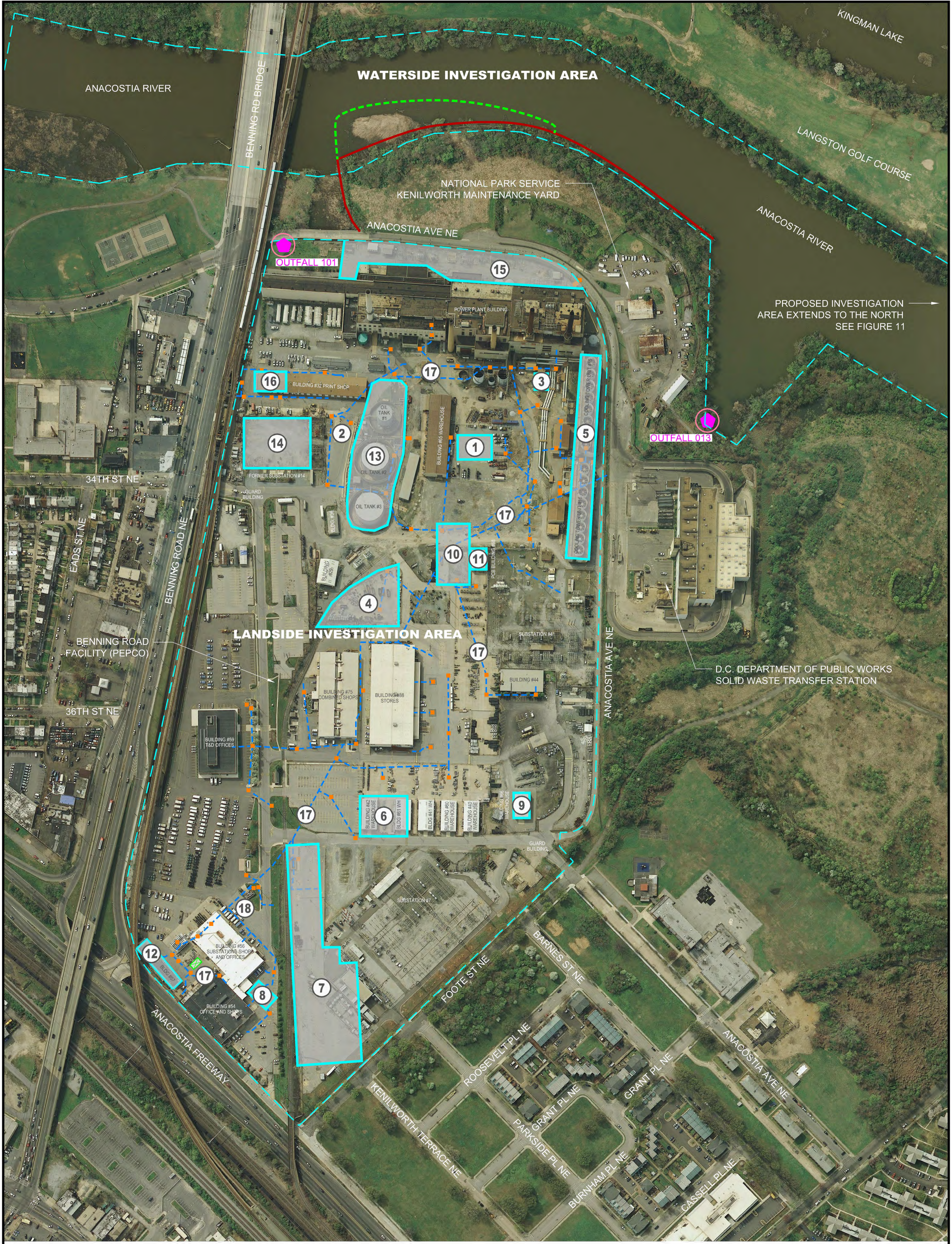
AECOM

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

Site Plan
And Investigation Areas

DATE: 02/27/2013
DRAWN: LAD
CHECKED BY: RD

FIGURE 2



LEGEND:

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

AECOM

TARGET AREA KEY:

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

0 75 150 300
SCALE IN FEET

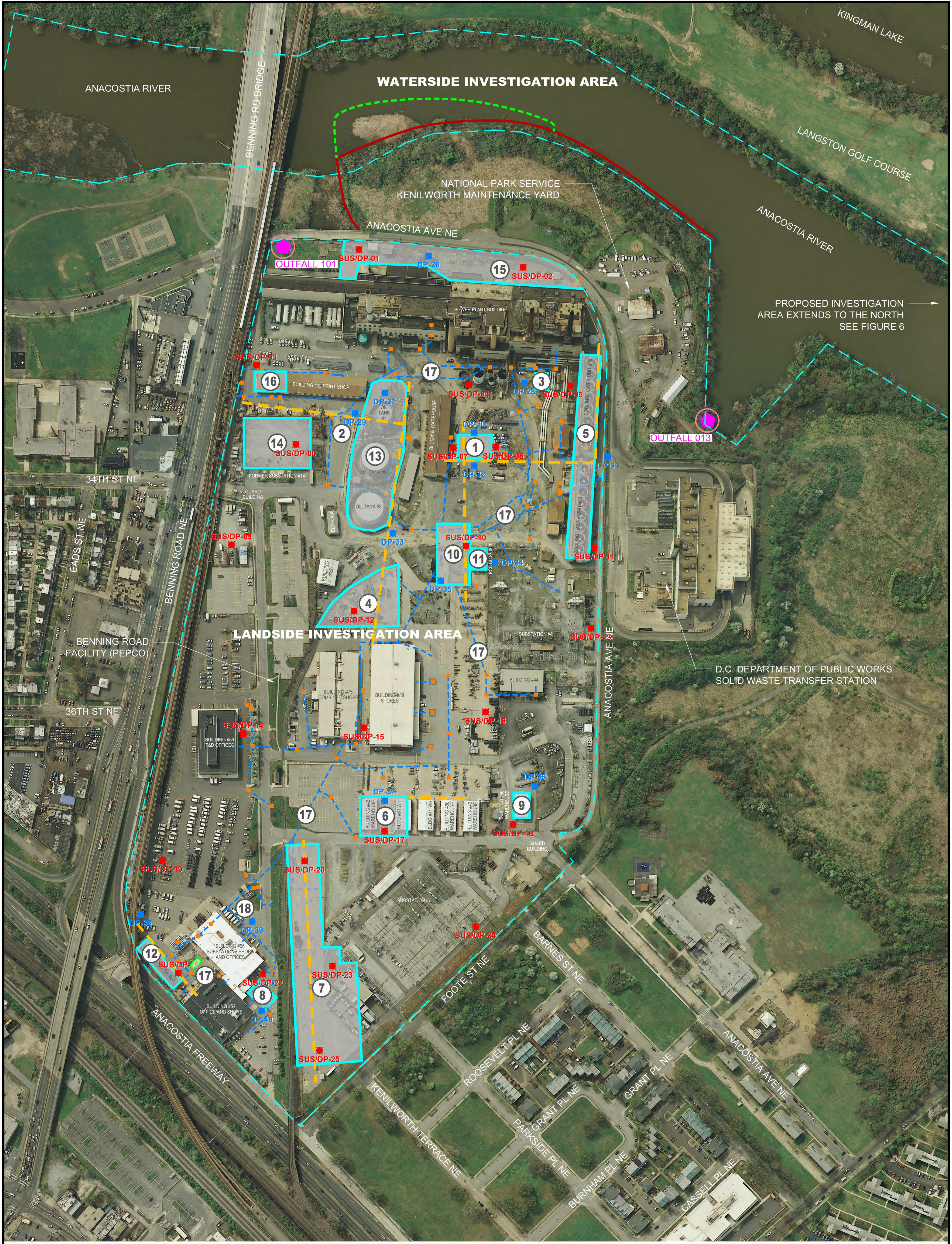
Benning Road Facility RI/FS Project
3400 Benning Rd., NE
Washington, DC 20019

Target Investigation Areas

DATE: 12/28/2012
DRAWN BY: LAD
CHECKED BY: RD

FIGURE 3

File: P:\Environment Projects\60249055 – PEPCO – Benning Rd Facility\Work Plan\Prop Soil Samples.dwg Layout: Fig 10 User: deskinsl Plotted: Dec 28, 2012 – 9:56am Xref's:



LEGEND:

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

TARGET AREA KEY:

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

0 75 150 300
SCALE IN FEET

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

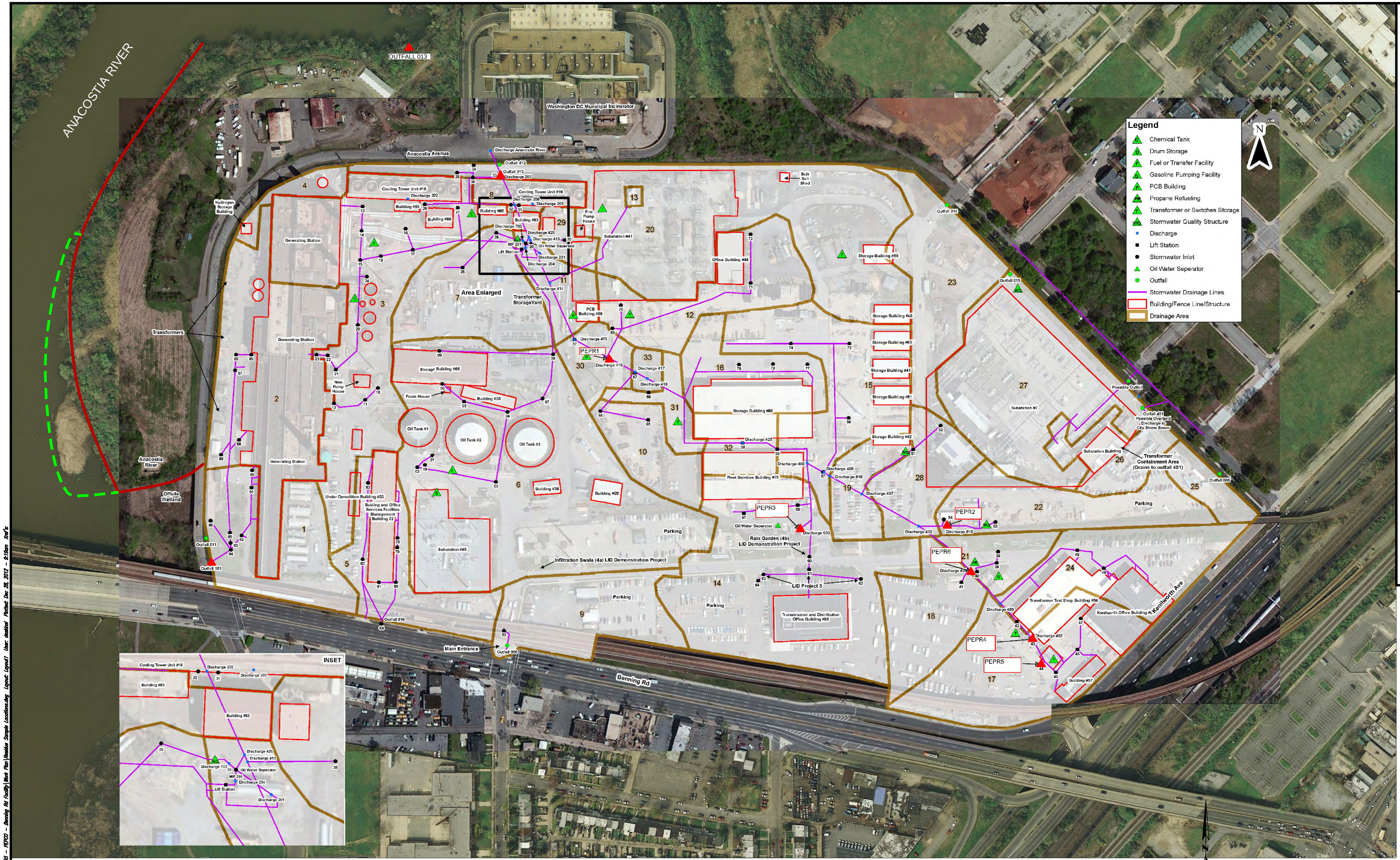
AECOM

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

Proposed Soil Sample and ERI Transect Locations

DATE: 12/28/2012 DRAWN BY: LAD CHECKED BY: RD

FIGURE 4



LEGEND:

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

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

NOT TO SCALE

Proposed Sediment/Residue Sample Location Map

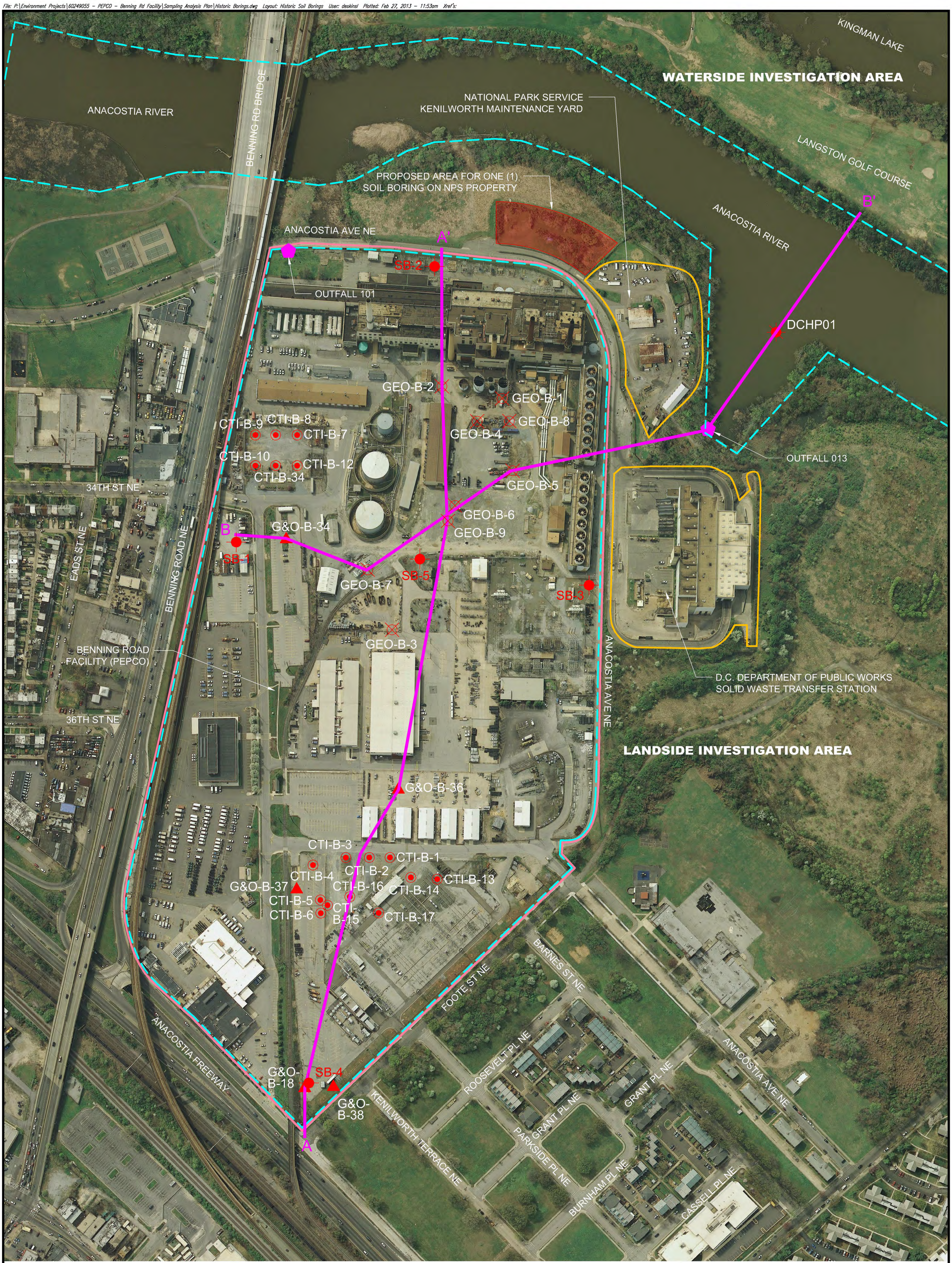
FIGURE 5

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

DATE: 12/28/2012
DRAWN BY: LAD
CHECKED BY: RD

AECOM

File: P:\Environment Projects\60249055 – PEPCO – Benning Rd Facility\Work Plan\Residue Sample Locations.dwg Layout: Layout1 User: deskinsl Plotted: Dec 28, 2012 – 9:19am Xref's:



LEGEND:

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

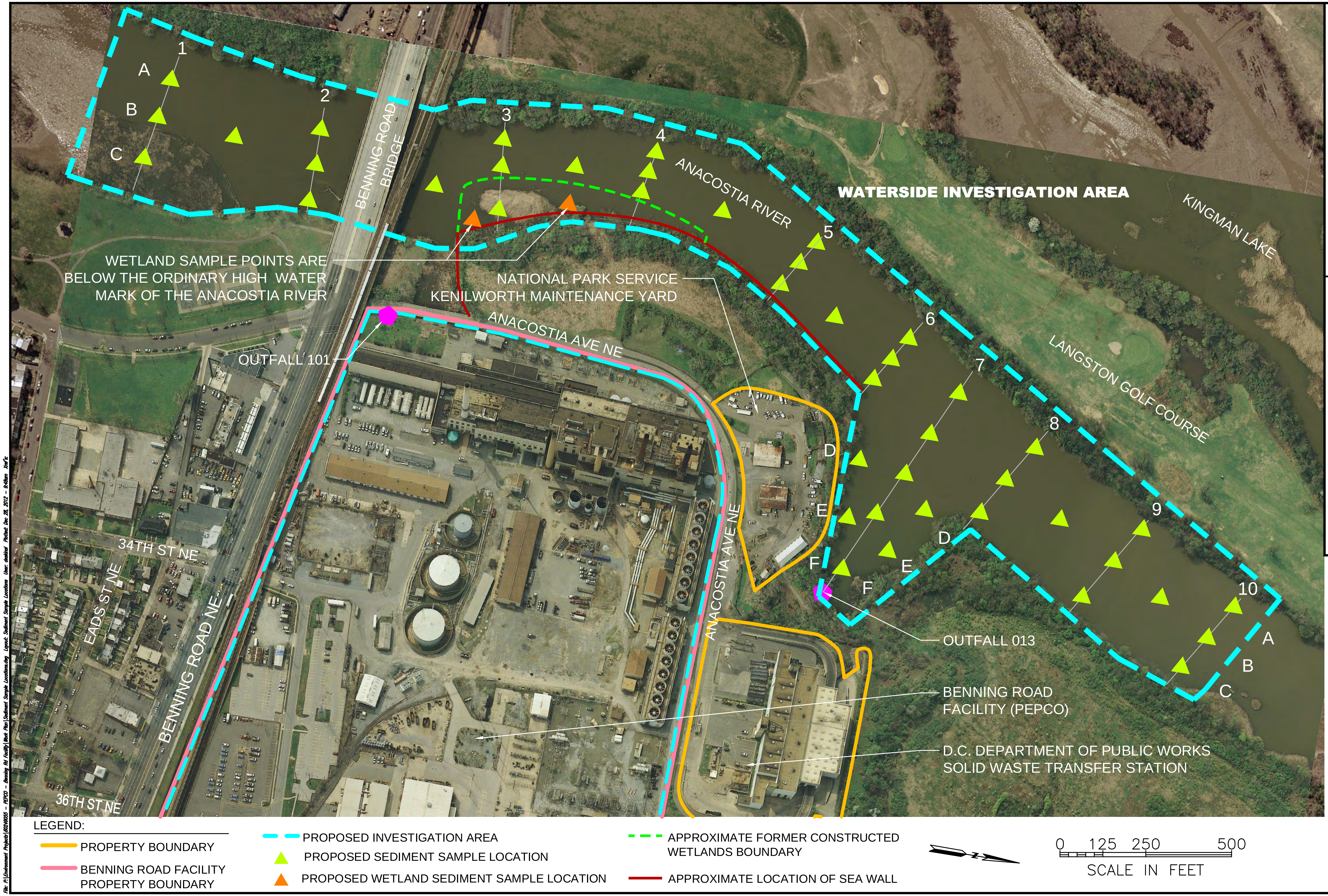
0 75 150 300
SCALE IN FEET

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

HISTORICAL AND PROPOSED SOIL BORINGS

DATE: 02/27/2013 DRAWN BY: LAD CHECKED BY: RD

FIGURE 6



Sediment Sample Locations

FIGURE 7

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

DATE: 12/28/2012 DRAWN BY: LAD CHECKED BY: RD

AECOM

File: P:\Environment Projects\60249055 - PEPCO - Benning Rd Facility\Work Plan\Sediment Sample Locations\Sediment Sample Locations.dwg Layout: Sediment Sample Locations User: deskinsl Plotted: Dec 28, 2012 - 9:48am Xref's:

CHAIN-OF-CUSTODY RECORD

AECOM

Company Name and Phone Number:	Project Manager
Project Name:	Client ID:
Sampler(s):	P.O. Number:

Field Sample ID	Date	Time	Water	Soil	Other	No. Of Containers	Parameters										Preservative/Remarks	MSS Lab ID

Relinquished by: *(Signature)* (Printed)	Date/Time	Received by: *(Signature)* (Printed)	Relinquished by: *(Signature)* (Printed)	Date/Time	Received by: *(Signature)* (Printed)
Relinquished by: *(Signature)* (Printed)	Date/Time	Received by Laboratory: *(Signature)* (Printed)	Date/Time	Remarks Page ____ of ____	

1.04

AECOM

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

Chain Of Custody Record

DATE: 12/28/2012

DRAWN BY: LAD

CHECKED BY: RD

FIGURE 8

Tables

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

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

Notes:
TA - Target Area
* Area identified as waterside investigation area.

Table 2
Landside Data Quality Objectives
Benning Road Facility
3400 Benning Road, N.E.
Washington, DC

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

Table 2
Landside Data Quality Objectives
Benning Road Facility
3400 Benning Road, N.E.
Washington, DC

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

Table 2
Landside Data Quality Objectives
Benning Road Facility
3400 Benning Road, N.E.
Washington, DC

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

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

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

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

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

Table 4
Landside Data Collection Program
Benning Road Facility
3400 Benning Rd, N.E.
Washington, DC

Data Type	Data Use	Approximate Quantity	Methods
Surface Soil Samples (Phase I)			
Chemical analysis	Evaluation of surface soil quality	20 locations	TPH (8015), VOC (8260), PCB (8082), Metals, EPA 16 PAHs (8270)
		Up to 10 locations	VOCs (8260), SVOCs (8270), Pesticides, and Dioxins/furans
Forensic analysis	Evaluation of PCB and PAH origin and contribution	Up to 5 locations	PCB 680 Homologs and/or PCB 1668 Congeners, PAH fingerprinting
Storm Drain System (leading to Outfall 013) Sampling (Phase I)			
Water	Surface water discharge pathway	Up to 9 locations	PCBs (8082), EPA 16 PAHs (8270), dissolved and total Metals, VOCs (8260), TPH (8015), Pesticides
Sediment	Surface water discharge pathway	Up to 9 locations	PCBs (8082), EPA 16 PAHs (8270), Metals, VOCs (8260), TPH (8015), Pesticides
Forensic samples	PCB and PAH origin, site reference, surface water pathway	Up to 2 locations	PCB 680 Homologs, PCB 1668 Congeners, PAH fingerprinting, dioxins/furans
Surface Geophysics (Phase I)			
Electrical Resistive Imaging (ERI)	Evaluation of subsurface geology, obstructions, NAPL plumes and optimization of soil boring and monitoring well placement	Up to 8 transects of 300-500 ft long	Geo Trax™ Survey
Soil Borings to 100 ft below grade (Phase I)			
Lithology	Subsurface geology	Continuous	Visual identification
PID Reading	Screening for VOCs	Continuous	Field methods
Geotechnical	Subsurface geology	25 samples (5 locations, and up to 5 samples per location)	ASTM Grain size and Atterberg limits
Geotechnical	Subsurface geology	10 Shelby tubes (5 locations and two samples per boring)	ASTM Permeability

Table 4
Landside Data Collection Program
Benning Road Facility
3400 Benning Rd, N.E.
Washington, DC

Subsurface Soil and Groundwater Samples (Phase II)			
Direct Push (Geoprobe™) Borings to 5 ft below groundwater	Subsurface geology, identification of free phase oils	40 locations	Visual identification
VOC Vapor Screen	Rapid characterization, flexibility to field adjust sampling grid	Continuous	Photoionization Detector (PID) field instrument
Metals screen	Subsurface soil quality, rapid characterization, flexibility to field adjust sampling grid	120 samples (three depths at 40 locations)	X-Ray Fluorescenece (XRF) field instrument
Soil chemical	Rapid characterization, flexibility to field adjust sampling grid	120 samples (three depths at 40 locations)	Mobile lab TPH (8015) and PCBs (8082)
Soil chemical	Metals confirmation/correlation	24 samples (20% of 120)	Metals (fixed lab)
Soil chemcial	Evaluation of subsurface soil quality	Up to 40 samples	VOCs (8260), PAHs (8270)
Soil chemical	Evaluation of subsurface soil quality	Up to 10 samples	Pesticides, SVOC (8270), dioxins/furans
Groundwater chemical	Evaluation of groundwater quality	40 locations	Mobile lab TPH (8015) and PCBs (8082)
Groundwater chemical	Evaluation of groundwater quality	40 locations	VOCs (8260), EPA 16 PAHs (8270), total and dissolved metals
Groundwater chemical	Evaluation of groundwater quality	Up to 10 samples	Pesticides, SVOC (8270), dioxins/furans
Forensic analysis	Evaluation of PCB and PAH origin and contribution	Up to 5 soi/groundwater samples	PCB 680 Homologs, PCB 1668 Congeners, PAH fingerprinting
Monitoring Wells to the top of Arundel Clay (Phase III)			
GW elevation monitoring	Determine depth to groundwater and groundwater gradient	2 episodes	Gauging
Aquifer testing	Evaluation of aquifer characteristics	8 locations and 2 screened zones	Slug Testing
Chemical analysis	Evaluation of groundwater quality	16 samples (8 locations and 2 screened zones per location)	VOC (8260), PCB (8082), dissolved and total Metals, EPA 16 PAHs (8270), SVOC (8270), pesticides
Chemical analysis	Evaluation of groundwater quality	Up to 10 samples	Pesticides, dioxins/furans
Forensic analysis	Evaluation of PCB and PAH origin and contribution	Up to 8 samples	PCB 680 Homologs and/or PCB 1668 Congeners, PAH fingerprinting
Civil Surveying			
Horizontal and vertical surveys	To locate all sampling points	All locations sampled in Phases I, II and III	GPS surveys

Table 5
Waterside Data Collection Program
Benning Road Facility RI/FS Project
3400 Benning Rd, N.E.
Washington, DC

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

Table 6
Summary of Calibration Frequency and Criterion for Field Instruments
Benning Road Facility
3400 Benning Road, N.E.
Washington, DC

Instrument	Calibration Frequency	Calibration Standards	Acceptance Criteria
pH meter	Initial: Each time instrument is turned on or upon erratic results	Two reference buffers which bracket expected sample values	Within ≤0.1 pH unit of true value
	Check: Every 15 samples and at the end of the day	pH 7 reference buffer	Within ≤0.1 pH unit of true value or instrument will be recalibrated
Specific conductivity meter	Initial: Each time instrument is turned on or upon erratic results	Two reference standards	Within 10% of true value
	Check: Every 15 samples and at the end of the day	Initial reference standard	Within 10% of true value or instrument will be recalibrated
DO meter	Initial: Each time the instrument is turned on or upon erratic results	Moist air	Within 5% of true value (based on altitude and temperature)
	Check: Every 15 samples and at the end of the day	Moist air	Within 5% of true value or instrument will be recalibrated
ORP meter	Initial: Each time instrument is turned on or upon erratic results	Two reference standards	Within 10% of true value
	Check: Every 15 samples and at the end of the day	Initial reference standard	Within 10% of true value or instrument will be recalibrated
Turbidity meter	Initial: Each time the instrument is turned on or upon erratic results	Two standards	Within 10% of true value
	Check: Every 15 samples or upon erratic results	Higher of initial reference standards	Within 10% of true value or instrument will be recalibrated
Temperature meter	Initial: Factory calibrated annually; no field calibration required.	NA	NA
	Check: Prior to use in field	Mercury bulb thermometer	Within 0.5°C of bulb thermometer or instrument will be replaced
Water Level Tape	Beginning, middle, and end of field program	Check against a manual water level measurement (steel tape)	Within 0.1 ft
PID	Initial: Each time the instrument is turned on or upon erratic results	Clean ambient air and compressed gas standard (isobutylene at 100ppm)	Within 5% of true value
	Check: Mid and end of the day	Compressed gas standard (isobutylene at 100 ppm)	Within 5% of true value
XRF	Initial: Each time the instrument is turned on or upon erratic results.	Use of certified reference standards/samples.	Within 2% of true value
	Check: Mid and end of the day	Initial reference standard	Within 2% of true value

Appendix A

AECOM Project Operating Procedures

Project Operating Procedures
Benning Road Facility RI/FS Project

Site:
Benning Road Facility
3400 Benning Road, N.E.
Washington, DC 20019

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Contents

List of Acronyms

°C	degrees Celsius
CFR	Code of Federal Regulations
°F	degrees Fahrenheit
DI	Deionize
DIUF	deionized ultra-filtered water
DO	dissolved oxygen
eV	electron volts
GPS	Global Positioning System
HASP	Health and Safety Plan
IDW	investigation derived waste
LNAPL	Light Non-Aqueous Phase Liquid
MDS	Multi parameter Display System
mg/L	Milligrams per liter (parts per million)
MS/MSD	Matrix Spike / Matrix Spike Duplicate
mV	millivolts
NCR	Nonconformance Report
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards & Technology
ORP	Oxidation Reduction Potential
OSHA	Occupational Safety and Health Administration
oz	ounce
PDA	Personal Digital Assistant
PID	photoionization detector
POP	Project Operating Procedure
PPE	personal protective equipment
ppm	parts per million
Project	Benning Road RI/FS
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RF	Outside Electronic Noise
SAP	Sampling and Analysis Plan
TOC	Top of Well Casing
µS/cm	microsiemen per centimeters
U.S. EPA	United States Environmental Protection Agency
UV	ultraviolet
VOCs	Volatile Organic Compounds
YSI	YSI Incorporated

Sediment Core Sampling – POP 005

1.0 Scope and Applicability

Selection and proper use of sediment sampling equipment is essential to the collection of accurate, representative sediment data that will meet the project Data Quality Objectives (DQOs). Most sediment collection devices are designed to isolate and consistently retrieve a specified volume and surface area of sediment, from a required depth below the sediment surface, with minimal disruption of the integrity of the sample and no contamination of the sample. The purpose of this document is to define the project operating procedure (POP) for collecting sediment cores using a vibracoring device.

This POP describes the equipment, field procedures, materials, and documentation procedures necessary to collect cores associated with the Benning Road Project using a vibracore.

2.0 Health and Safety Considerations

The health and safety considerations for the work associated with this POP, including physical, chemical, and biological hazards, are addressed in the site specific Health and Safety Plan (HASP; AECOM 2010) and associated task hazard analysis forms (THAs).

The health and safety considerations for the work associated with vibracoring include:

- The physical hazards of handling heavy equipment,
- Overhead lifting hazards using boat based winches and A-frames,
- Marine safety aspects of the program, and
- The specific chemical hazards related to the sediments.

Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the Site Safety Officer (SSO) or his/her designee to discuss the day’s events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the site specific HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.

If sampling from a boat, all sampling personnel must wear personal flotation devices (PFDs) when in the boat, and must follow all health and safety protocols for working in a boat presented in the project-specific health and safety plan. Care should be taken to avoid splashing when lowering the sampler and/or messenger into the water. Lifting the samplers into the boat, dumping its contents, and washing those contents may require leaning over the side of the boat. Care should be taken to keep the boat in proper balance at all times during sampling.

3.0 Interferences

Cross contamination may occur if the sediment samplers and associated equipment are not properly decontaminated between each use. Procedures for proper decontamination of field equipment are presented in POP 105-Decontamination of Field Equipment. Sampler-specific interferences are presented below.

Vibracoring methodologies can disrupt surface sediment, as well as consolidate/compact sediment layers and restrict the entry of soft horizons from entering the core tube thereby biasing profile results and confusing recovery information.

The Field Task Manager should continually monitor the core progression and ensure that the core sample is not vibrated excessively if the downward progression has ceased. Common interferences encountered during core driving include:

Interference	Possible Effect	Action Taken to Minimize Effect
Vibratory action	Consolidate/compact sediment during driving	Free fall the corer when possible and vibrate only as needed to advance the tube; use of a piston to improve recovery; establish minimum acceptance criteria
Loss of material out bottom	Less drive length achieved; gaps in retained sediment	Use core catcher
Blocking	Material doesn’t enter core	Move off station and re-drive; establish minimum acceptance criteria

	tube or lessens recovery	
Angled entry	Drive length less than expected and fore-shortened	Make sure that wire line is vertical before core driving

4.0 Equipment and Materials

Sampler-specific equipment and supplies are listed below. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Personal protective equipment (PPE) and other safety equipment (refer to HASP);
- Sampling vessel;
- GPS or other positioning equipment;
- Vibracore device;
- Deployment equipment (e.g., A-frames, winches, generator);
- Decontaminated core tubes liners;
- Decontaminated stainless steel core catcher;
- Decontaminated stainless steel core cutter;
- Core storage racks to hold cores vertical and cold during temporary storage on-board coring vessel;
- Waterproof logbooks, pens, and labels;
- Core collection log
- Permanent marker or grease pencil;
- Line with weight and 0.1 foot increments indicated
- Tape measure and ruler;
- Tubing;
- Core tube caps;
- Electrical or duct tape;
- Cell phone
- Nitrile gloves
- Polarized sunglasses
- Sample containers, labels, and preservatives
- Personal flotation devices (PFDs), if sampling from a boat
- Chest waders, if sampling on foot
- Surveyor rod or weighted line, if sampling on foot
- Camera; and
- Decontamination equipment/supplies (POP 012- Decontamination of Field Equipment).

5.0 Procedures

Depending on the characteristics of the site being investigated, sediment core samples may be collected from a boat, or by sampling personnel in waders. In all instances, sediment sampling should begin from the most downstream location and proceed to the most upstream location. If sediment samples are collocated with surface water samples, the surface water sample should be collected prior to the sediment sample in order to avoid increased turbidity from displaced sediment. Regardless of the type of sediment sampling equipment used, documentation of field observations and collection activities should be recorded on the sediment sampling sheet. The following observations should be recorded on the sediment sampling sheet for all sediment sampling activities:

- Weather conditions and other relevant site conditions

- Sample location
- Depth of water to the nearest 0.1 foot. A surveyor rod or weighted line may be used. If the surveyor rod is used, minimize water turbulence and do not disturb any sediment.
- Physical characteristics of the water body such as estimated current speed (stagnant, slow, medium, or fast) and direction, odor, color, presence of any dead vegetation, surface sheens, etc.
- Sediment color
- Sediment grain size

Specific procedures for the collection of sediment core samples using a vibracoring device are presented below.

5.1 Sampling procedures

This section gives the step-by-step procedures for collecting cores using a vibracore. Observations made during sediment core collection should be recorded on core collection log and logbook.

5.2 Decontamination of equipment

Decontamination of the core tubes, stainless steel core cutter, and stainless steel core catcher assemblies will be performed prior to vessel departure in accordance with procedures outlined in POP 105 – Decontamination of Field Equipment). A sufficient amount of decontamination equipment and supplies will be brought on the coring vessel to accommodate the need for miscellaneous, unforeseen decontamination. New core liners/caps will be used for the project and will not require decontamination. The liners will be kept in the manufacturer-supplied packaging (plastic bag) until removed for use. Any liners not kept in closed packaging will be decontaminated prior to use according to POP 012 - Decontamination of Field Equipment.

5.3 Collection of cores

1. Initiate the Core Collection Log.
2. Put on all necessary PPE (including a PFD, if sampling by boat)
3. Attach core catcher
4. Obtain water depth (to nearest 0.1 foot)
5. Slowly lower the vibracore through the water column to the sediment surface using the winch or other deployment equipment.
6. Record the “zero” mark on the winch cable.
7. Slowly lower vibracore into sediment under its own weight until it stops.
8. Turn on the compressor/ actuate the hydraulics. Slowly penetrate the sediment to the target penetration, or until refusal.
9. Lower vibracore approximately 1 foot beyond target to obtain a “plug” at the bottom of the core (i.e., to minimize loss of sediment from core).
10. Upon completion of the required penetration, or upon vibracore refusal, turn the compressor/ hydraulics off. Record the vibracore penetration depth on the Core Collection Log.
11. Record the final core location coordinates.
12. Slowly raise the vibracore, while maintaining the core in a vertical position as field conditions allow.
13. Bring vibracore to sampling vessel deck while maintaining the core in a vertical position. Remove core cutter and core catcher, replace with cap, and secure cap with duct tape.
14. Clean the vibracore barrel and coring assembly by hosing down the equipment with site water as described in POP 105 – Decontamination of Field Equipment.
15. Remove the core tube from the vibracore barrel and place a cap on bottom of the coring tube, keeping the core tube in an upright position, as field conditions allow.
16. Return the vibracore device to its onboard, deck storage location.

17. Clean the core tube by hosing it down with site water. Care should be taken not to direct water into the open end of the core tube.
18. Evaluate whether core penetration and recovery are acceptable using the procedures outlined in Sections 5.4 and 5.5, respectively.
19. Keeping the core tube upright, as field conditions allow, use a core cutter to cut/hole in the core tube approximately 3 to 4 inches above the sediment to allow excess water to seep from the core tube. Continue to make cuts/holes in the core tube, lowering 1 inch each time until reaching the sediment/water interface. When all excess water has been drained from above the sediment/water interface, cut off excess core tube.
20. Cap the cut end of the tube, secure cap with duct tape, and draw an arrow toward the cap. Draw an arrow on the coring tube with permanent marker and label “top” to indicate the top of the core. Label the core with the location ID, date, and time, and record this information on the Core Collection Log.
21. Measure the recovered length of the sediment in the core tube (to the nearest 0.1 foot to the extent possible) and record it on the Log. The distance between the top of the sediment in the coring tube and the bottom of the coring tube corresponds to the recovered length. Apparent gaps should be noted on the Log and the length and location(s) of the gap(s) should be noted. The total gap length will be subtracted from the total recovery length.
22. Store the core vertically in a core storage rack (capable of keeping cores cold) while on the vessel until it can be transported to the sample processing area. Cores greater than 4 feet will be segmented on the vessel to allow for storage and transportation. Cut these cores at the location of a planned sample segmentation using a core cutter and recap the exposed ends. Add appropriate markings to indicate the location and segment of each section.

5.4 Procedures for determining acceptable core penetration

1. Calculate penetration percentage using the following equation:

$$\text{Penetration}\,(\%) = \frac{\text{actual penetration}\,(\text{feet})}{\text{target penetration}\,(\text{feet})} \times 100$$

   Actual penetration is the depth advanced into the sediment not including the depth advanced to form a plug.
2. Record penetration percentage on the Core Collection Log.
3. If penetration is ≥80%, then penetration is acceptable. Proceed to Section 5.5, Procedures for Determining Acceptable Core Recovery.
4. If penetration is <80%, then (a) retain core and (b) record on the Core Collection Log if due to refusal. Reposition vessel and redeploy coring device. Upon three unsuccessful attempts to obtain >80% penetration, contact Project Manager or Field Task Manager to determine if additional cores should be attempted.

5.5 Procedures for determining acceptable core recovery

1. Calculate recovery percentage by the following equation:

$$\text{Recovery}\,(\%) = \frac{\text{recovery}\,(\text{feet}) - \text{gaps}\,(\text{feet})}{\text{actual penetration}\,(\text{feet})} \times 100$$

2. Record recovery percentage on the Core Collection Log.
3. If recovery is ≥80%, then recovery is acceptable. Continue processing core, then move to a new core location.
4. If recovery is <80%, then (a) retain core and (b) move to a new coring position and redeploy coring device. Upon three unsuccessful attempts to obtain >80% recovery, contact Project Manager or Field Task Manager to determine if additional cores should be attempted.

5. Record all attempts on the Core Collection Log. Communications with the Field Task Manager will be documented in the field logbook. Failure to collect a core at a specified location will be recorded in the logbook.

5.6 Management of cores

1. Verify that the lengths of the core tubes, water depth, and positioning data have been recorded on the Core Collection Log.
2. Prior to transit to the next coring location or returning to shore, decontaminate the coring equipment and sampling vessel decking as described in POP 105 – Decontamination of Field Equipment.
3. Proceed to next core location specified for that day and repeat above procedures.
4. Completed Core Collection Logs and a Sample Chain of Custody will be provided when relinquishing cores for processing/analysis.

5.7 Core processing

1. Each core will be logged, photographed, and sub-sampled as per the specified analytes require.
2. The appropriate sediment horizon will be removed from the core tube using a stainless steel spoon/scoop and placed in a decontaminated 1-gallon stainless steel or Pyrex glass mixing bowl.
3. Each sample will be visually examined for physical characteristics such as composition, layering, odor, and discoloration.
4. Samples will be homogenized in the mixing bowl and placed in appropriate sample containers.
5. Sediment sampling equipment such as bowls, spoons, augers, and dredges will be decontaminated prior to and following sample collection as described in POP 105.

6.0 Quality Assurance / Quality Control

All sediment sampling equipment will be thoroughly decontaminated prior to and in between use according to the procedures described in POP 105- Decontamination of Field Equipment

Field accuracy will be assessed through the collection and analysis of equipment blanks. Equipment blanks will be collected for each type of sediment sampling equipment in accordance with the Sampling and Analysis Plan (SAP).

Field precision will be assessed through the collection and analysis of field duplicates. Field duplicates will be collected in accordance with the SAP.

Entries on the forms and in the field logbook will be double-checked by the samplers to verify the information is correct. Completed forms will be reviewed periodically by the Field Task Manager and/or Project Quality Assurance Officer or his/her designees to verify that the requirements are being met.

7.0 Data and Records Management

All data and information (e.g. type of sample equipment used) must be documented on the sediment coring log and/or field logbooks with permanent ink. Deviations to the procedures detailed in this POP should be recorded in the field logbook.

Data recorded will include the following:

- Weather conditions
- Sample location
- Sampling equipment type
- Date and time of sample collection, and the initials of the sampler
- Sediment characteristics (e.g. color and particle size)
- Depth of sediment sampled
- Water depth

- Physical characteristics of the water body such as estimated current speed (stagnant, slow, medium, or fast), odor, color, presence of any dead vegetation, surface sheens, etc.
- Samples and quality assurance/quality control (QA/QC) samples collected

The chain of custody form will be completed following sample collection describing all pertinent sample information, site information, intended analyses, etc. This form must be completed properly and the intended recipients must receive their respective copies.

8.0 Personnel Qualifications and Training

All field samplers are required to take the 40-hour Occupational Health and Safety Administration (OSHA) Hazardous Waste Operations training course and annual 8-hour refresher training prior to engaging in any field collection activities. The individuals executing these procedures will have read, and be familiar with, the requirements of this POP and the corresponding Work plan. Actual vibracoring operations will be conducted only by personnel experienced with the equipment, but subsequent manipulations, measurements, cutting and labeling procedures are relatively simple and can be implemented by personnel without specialized training. It is recommended that initial core manipulations and handling activities be supervised by more experienced personnel

The Project Manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this POP and the project plan. In the absence of a Field Team Leader, the Project Manager is responsible for ensuring that field records are reviewed and approved as described below.

The Field Team Leader is responsible for reviewing and approving the field records for accuracy, completeness, and conformance to the procedures in this POP.

Field personnel are responsible for recording data according to the procedures outlined in this POP.

9.0 References

POP 101-. Field Records

POP 105- Decontamination of Field Equipment

Sealed-Screen Groundwater Profiling – PO 016

1.0 Scope and Applicability

This Project Operating Procedure (POP) defines the procedures for sealed-screen groundwater profiling. Sealed-screen samplers typically consist of a PVC or stainless steel screen nested within a sealed, water-tight sheath. This procedure is used as an efficient means of collecting screening-level groundwater data such as water quality parameters and contaminant concentrations. The data quality should be sufficient enough such that informed decisions can be made when delineating contaminant plumes, inferring source areas, identifying other potential soil sample locations and/or locations for permanent monitoring well installation, and performing contaminant fate and transport evaluations.

2.0 Health and Safety Considerations

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, will be addressed in the site specific Health and Safety Plan (HASP). In the absence of a site-specific HASP, work will be conducted according to the AECOM Health and Safety Policy and Procedures Manual and/or direction from the Regional Health and Safety Manager.

3.0 Interferences

Sealed-screen samplers generally are limited to collecting one sample per advance of the sampler. Because the screen is not exposed to the formation as the sampler is advanced into the subsurface, the screen does not become plugged or damaged. In addition, the potential for cross contamination is greatly reduced and a depth-discrete sample that is representative of the target sampling zone can be collected. However, depending upon the system used, multi-level sampling in a single borehole can be accomplished with sealed-screen samplers by retrieving the sampler and decontaminating it or replacing it with a clean sampler before reentering the hole to collect another sample. The potential for cross contamination may be minimized by purging the screen point prior to collecting a sample. This profiling process may be conducted with an understanding of data quality objectives.

Gas bubbles present in discharge tubing during purging and sampling are a problem: Their presence indicates off-gassing from groundwater or poor purging connections in the airline or groundwater tubing. Sunlight can exacerbate this problem when low pumping rates are used. Check connections at the surface. If bubbles persist, check connections at the pump. During purging and sampling, observe the flow of groundwater in the sample tubing and keep the tubing filled with groundwater, removing all air pockets and bubbles, to the extent possible. Gas bubbles may be reduced by increasing flow, if possible, and keeping tubing shaded.

Pump tubing lengths above the top of the drill rod should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to de-gas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

4.0 Equipment and Materials

4.1 Sealed-Screen Groundwater Sampler

A sealed-screen groundwater sampler (e.g. Geoprobe® Screen Point 22 Groundwater Sampler) is a direct push device consisting of a PVC or stainless steel screen that is driven to depth within a sealed, water-tight sheath and then deployed for the collection of representative groundwater samples. Upon deployment, up to 48 inches of screen can be exposed to the formation.

4.2 Mechanical Bladder Pump

A submersible mechanical bladder pump (e.g. Geoprobe® Model MB470 Mechanical Bladder Pump) will be deployed within the sealed-screen groundwater sampler once it has been installed by direct push advancement. The mechanical bladder pump consists of a corrugated bladder which is mechanically compressed and expanded to push groundwater to the surface through concentric tubing. Teflon or Teflon-lined polyethylene bladder pumps are preferred for sampling VOCs. Check valves above and below the bladder control flow direction. The outer tube of the concentric tubing set holds the pump body in place while the inner tube is used to actuate the bladder and transmit water to the surface. The bladder pump assembly must accommodate the ID of the probe rods and screen point which typically is 0.5 inch and be long enough to maneuver past rod joints typically occurring every 10 feet. For example, the Geoprobe® Model MB470 Mechanical Bladder Pump has internal components made of stainless steel with an OD of 0.47 inches and an overall length of 26.75 inches with an inlet screen assembly installed

4.3 Inertia Lift Pump

A check-valve affixed to HDPE tubing may be used to withdrawal groundwater from within the screen for purging. The OD of the check-valve should be closely equivalent to the ID of the screen to maximize inertia, as such a surge block may be necessary in conjunction with the check-valve. This method is not preferred for sampling because agitation of groundwater within and around the sample point may result in increased turbidity and sediment load. Samples collected using this method will likely require additional field or laboratory filtration.

4.4 Tubing

Teflon or Teflon-lined polyethylene tubing are preferred for sampling VOCs. Inner tubing diameter should be kept to the smallest size possible to reduce the generation of air pockets during low flow.

5.0 Procedures

5.1 Sealed-Screen Advancement

A direct push rig will advance the sealed-screen sampler to the desired sampling depth. Inner rods will be installed to hold the inner screen in place while the outer sheath is retracted to reveal the screen to the formation. The inner rods can then be removed and the depth to water and total depth of water can be measured using a water level indicator.

5.2 Groundwater Sampling

Samples should be collected in order of decreasing volatility and reactivity so that the most volatile or reactive samples are collected first. The following are general guidelines presented in the order that samples should be collected.

- Volatile Organic Compounds
- Semivolatile Organic Compounds
- Nonvolatile Organic Compounds and Inorganics

During sample collection, allow the water to flow directly into and down the side of the sample container without allowing the tubing to touch the inside of the sample container or lid, in order to minimize aeration and maintain sample integrity.

For metals, collect filtered and unfiltered samples using a 0.45 micron filter for analyses that may be impacted by the elevated turbidity.

5.3 Grouting

Grouting or sealing the borehole with bentonite will be performed during removal of the drill string or following the retrieval of all down-hole equipment.

5.4 Decontamination

All non-dedicated down-well measuring devices (i.e. mechanical bladder pump and water level indicator) will be thoroughly decontaminated before sampling.

6.0 Quality Assurance / Quality Control

Sampling personnel should follow specific quality assurance guidelines as outlined in the QAPP. Proper quality assurance requirements should be provided which will allow for collection of representative samples from representative sampling points. Quality assurance requirements outlined in the QAPP typically suggest the collection of a sufficient quantity of field duplicate, field blank, and other samples.

Quality control requirements are dependent on project-specific sampling objectives. The QAPP will provide requirements for equipment decontamination (frequency and materials), sample preservation and holding times, sample container types, sample packaging and shipment, as well as requirements for the collection of various quality assurance samples such as trip blanks, field blanks, equipment blanks, and field duplicate samples.

7.0 Data and Records Management

Groundwater sampling information specific to each sealed-screen groundwater profiling will be recorded in the field logbook or on a field sample collection sheet. Activities common to more than one sampling location, samples collected, deviations from the POP, QAPP, or Work Plan, and any other unusual occurrences will also be documented in the field logbook in accordance with standard documentation procedures.

Unanticipated changes to the procedures or materials described in this POP (deviations) will be appropriately documented in the project records.

Records associated with the activities described in this POP will be maintained according to the document management policy for the project.

8.0 Personnel Qualifications and Training

8.1 Qualifications and Training

The individual executing these procedures must have read, and be familiar with, the requirements of this POP.

8.2 Responsibilities

The project manager is responsible for providing the project team with the materials, resources and guidance necessary to properly execute the procedures described in this POP.

The individual performing the work is responsible for implementing the procedures as described in this POP and any project-specific work plans.

The entire sampling team should read and be familiar with the site Health and Safety Plan, Work Plan, QAPP (and the most recent amendments), and all relevant POPs before going on site for the sampling event.

9.0 References

United States Environmental Protection Agency. 2001. Guidance for Preparing Standard Operating Procedures (SOPs). EPA QA/G-6. EPA/240/B-01/004. USEPA Office of Environmental Information, Washington, DC. March 2001.

Connecticut Department of Environmental Protection (CTDEP) 2009. Use of Filters in Groundwater Sampling Technical Guidance Document. June 29, 2009.

United States Environmental Protection Agency. 2005. Groundwater Sampling and Monitoring using Direct Push Technologies. OSWER No. 9200.1-51 EPA 540/R-04/005. USEPA Office of Environmental Information, Washington, DC. August 2005.

Niton XL3t 600 XRF – POP 028

1.0 Scope and Applicability

This Project Operating Procedure (POP) provides the proper techniques for safely operating the Niton XL 3t 600 X-Ray fluorescence (XRF) analyzer for field screening of metals, primarily chromium, in soil. The procedure will permit in-situ analysis of soil samples for field decision making and will be used for delineation purposes during the remedial investigation. This procedure is not intended for submission of data to regulatory agencies; confirmatory analysis must be performed by a certified laboratory using EPA total metals methods.

This procedure is to be used in conjunction with the site specific Field Sampling Plan. This procedure is intended to provide the necessary information for setting up and analyzing soil samples with the XRF analyzer and performing associated quality control procedures.

This procedure is to be used in conjunction with the Niton XL 3t 600 XRF User's Guide. This procedure will provide the basic information for set up of the instrument and analysis of soil samples. However, certain custom functions are not covered in this procedure and must be referenced from the instruction manual.

The method sensitivity or lower limit of detection depends on a number of factors including physical and chemical matrix effects and interelement spectral interferences; in-situ analysis and testing of bagged samples are considered field screening procedures. More accurate measurements using XRF are highly dependent on sample homogeneity; samples must be prepared by sieving and potentially grinding to a uniform particle size in order to achieve the most accurate results.

In-situ XRF results alone are not acceptable for determining that a sample is below cleanup levels. In these cases XRF must be performed on a prepared (homogenized) sample and confirmed using a certified laboratory.

2.0 Health and Safety Considerations

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, will be addressed in the site-specific Health and Safety Plan (HASP). In the absence of a site-specific HASP, work will be conducted according to the AECOM Health and Safety Policy and Procedures Manual and/or direction from the Regional Health and Safety Manager.

Field personnel are referred to the HASP for appropriate personal protective equipment (PPE) for this procedure.

The XRF analyzer contains an x-ray tube; when the x-ray tube is turned on by the user and the shutter is open, as during a measurement, the analyzer emits a directed radiation beam. The instrument should never be pointed at anyone or at any body part. Never point the analyzer into the air and perform a test. Never hold a sample in your hand and perform a test.

Each field analyst must undergo training in safe use of the instrumentation by a manufacturer's representative prior to use of the XRF equipment. Protective shielding should never be removed by the analyst or any personnel other than the manufacturer. All maintenance other than that specifically listed in the operating manual must be performed by the manufacturer.

Those operating XRF equipment must be aware of, and comply with, state-specific licensing requirements for the use of XRF analyzers (N.J.A.C 7:28-54.1). A copy of the license should be present with the instrument at all times and available upon request in an audit.

A copy of the United States Department of Transportation (US DOT) compliance statement has been provided with each Niton instrument; this document should be kept in the analyzer case at all times.

The analyst must comply with all safety requirements listed in the instrument specific operating manual.

3.0 Interferences

Physical matrix effects can result from variations in the physical character of the sample. This includes variations in particle size, uniformity, homogeneity and surface condition. As a minimum every effort should be made to thoroughly mix and homogenize samples before analysis. The most accurate data will be obtained if samples are sieved and ground to a uniform particle size prior to testing.

Moisture content of soils and sediments can impact analytical accuracy particularly if the sample is water saturated; moisture levels of 5-20% generally have a minimal impact on accuracy. If field data are to be compared with laboratory generated results, samples should be dried using a convection or toaster oven; a microwave should not be used due to the potential for arcing if metal fragments are present in the sample. Studies have also shown poor agreement between laboratory confirmatory analysis and field XRF data when microwave drying is used.

Inconsistent positioning of the sample in front of the probe window can produce errors since the x-ray signal decreases as the distance from the radioactive source increases. The best results are obtained when the sample has a flat, smooth surface and the probe window is in direct contact with the surface.

Chemical matrix effects can occur in soils contaminated with metals and result from spectral interferences (peak overlaps) or as x-ray absorption and enhancement phenomena. Peak overlaps occur when certain x-ray lines from different elements are close in energy; the degree to which these peaks can be resolved is dependent upon the instrument detector.

Elevated levels of vanadium have been documented as a potential interference for chromium. Absorption occurs when one element tends to absorb the x-rays of a second element reducing the detector's measurement of the intensity of the second element. Less common are interferences resulting from K/L, K/M, and L/M line overlaps; this interference can cause difficulty in detection of arsenic in the presence of high levels of lead.

Ambient temperature changes can result in instrument drift. The analyst should review the instrument instructions for the optimal operating range of the instrument and assess the accuracy of instrument response through periodic analysis of blanks and QC check samples.

4.0 Equipment and Materials

The following equipment and materials are required for sample analysis using this technique:

- Niton XL 3t 600 XRF
- Niton XL 3t 600 XRF User's Guide, Version 6.5
- U.S. DOT Compliance Statement and any state required licenses
- Battery charger and spare battery
- National Institute of Standards and Testing (NIST) certified standard reference material(s) (SRMs) or similar standards from the U.S. Geological Survey (USGS) or commercial sources.
- Reference standards and samples provided by the instrument manufacturer
- Blank sample of clean quartz, Teflon, or silicon dioxide
- Trowel for smoothing soil surface or collecting sample
- Plastic bags for collection and homogenization of soil samples.
- Field logbook and pen
- Level C PPE
- Camera (optional)

5.0 Procedures

5.1 Initial Setup

Don the PPE as instructed in the site-specific HASP.

- To turn on the analyzer depress the on/off/escape button on the control panel for 10 seconds; the start screen will appear and begin a 10 second countdown. When the log on screen appears, press anywhere on the screen to continue. Acknowledge the radiation warning by pressing "Yes" and enter the security code for the device.
- Confirm that the date/time display is correct. Refer to the Niton XL3t 600 User's Guide for specific instructions on navigation through the menu. If the instrument has been turned off for more than 30 minutes allow a 10 minute warm-up period before calibration. Select Calibrate and Test and press Clear/Enter to begin the self calibration; when the instrument beeps the calibration is complete and the instrument is ready for use.
- For the purposes of in-situ measurements, the instrument will be operated in the Standard Soil Mode. Select Standard Soil Mode from the Bulk Analysis Menu. Calibrate the instrument using the soil

standards supplied by Niton immediately after the instrument completes self-calibration. The standards should be tested every 1- 2 hours during the analysis day and at the conclusion of testing for the day to ensure that no drift has occurred. All calibration procedures and the results of standard check samples must be recorded in the XRF logbook. Until control limits specific to the XRF unit being used are established control limits of ± 20% of the true value should be used.

- The Niton XL3T 600 offers six modes of operation for soil samples. It is expected that the Easy Trigger method will be used for in-situ measurements. Using this technique the measurement window is placed against the sample and the trigger is pulled once to initiate the analysis. The instrument constantly checks the backscatter measurements to determine if a sample is against the measurement window and will shut off any radiation directed through the window if it determines there is no sample present.
- The analyzer will display the results screen throughout the duration of the reading; once the reading is complete, the screen will display the final results of the measurement.

5.2 Sample screening may be performed by holding the probe directly on the soil or on a bagged sample. Clean the measurement window between samples using a cotton swab.

- Remove any obviously non-representative materials such as leaves, vegetation, roots, or concrete from the sample; use caution that COPR related materials are not removed from the sample. Finer and more homogeneous material will yield more accurate results. Increased accuracy can be gained by loosening the soil and letting it dry in the sun prior to testing. The soil sample should not be saturated with water; the XRF technique will generally not produce reliable results if ponded water exists on the surface.
- Use a trowel to level the surface of the soil. Hold the XRF in one hand and place the instrument window flush against the surface of the sample to be tested. The four LED lights on the screen will flash to indicate the initiating preconditions have been met (see page 1-45 of the User's Guide); however as a safety precaution the x-ray tube will not turn on immediately and no reading will begin for approximately 0.5 seconds. Watch the display screen to determine when the test is complete; a typical test will take 30-60 seconds. To end the test simply release the trigger mechanism.
- If direct measurement of the sample is not possible, samples may be placed in plastic bags and analyzed without preparation. However, since the measurement is made through a plastic bag, test results can be 5-10% lower than those obtained by direct measurement. Place 50-100g of soil in a clean zipper locking bag (approximately 1- mil thick polyethylene bag is recommended) removing any obviously non- representative material. Mix the sample thoroughly by kneading the bag and flatten the bag of soil to form uniform layer of approximately 0.5 inch thickness. Place the XRF flat against the bag and take a measurement as described in Section 5.2.2. ***Do not hold the bag in your hand during testing.***

5.3 Download the stored data and spectra to a computer or directly to a database; erase the stored data from the XRF once you have confirmed that all results have been successfully downloaded. ***Do not attempt to take measurements while downloading readings, this will generate an error requiring a system reset and may corrupt stored readings.***

5.4 Routine maintenance procedures include cleaning and replacement of the measurement window.

- Keep the transparent measurement window covering the analysis window clean.
- Clean the measurement window gently with a cotton swab. Clean the body of the analyzer with a soft cloth. The touch screen may be cleaned using a lens cleaning solution with a soft cloth; water should not be used. Never use detergents or solvents on any portion of the analyzer or immerse the analyzer in water.
- 5.4.2 If the measurement window becomes frayed, ripped, or contaminated with metal particulates, replace it with a new window. The User's Guide provides part numbers and instructions for replacement of the windows.
- All other maintenance must be performed by an authorized Niton service center. The instrument must be transported and stored in its padded carrying case when not in use.

6.0 Quality Assurance / Quality Control

An energy calibration check should be run at the start of each day of sampling. This check confirms that the characteristic x-ray lines are stable and instrument drift is not occurring. This also provides a gain check if the ambient temperature fluctuates significantly. This test must be run at the start of each day, when the batteries are changed, when the instrument is shut down, and at the end of each day. This procedure should also be run any time the operator believes that drift is occurring during analysis.

A blank consisting of silicon dioxide or a Teflon or quartz block must be run at the beginning and end of each day of analysis and after every 20 samples or every hour of operation during the day or at any time the analyst suspects contamination in the analytical system.

An independent standard must be used to verify the accuracy of the instrument and confirm its stability and consistency for the analyte of interest. NIST, USGS or commercial standards may be used. The standard check must be performed at the beginning and end of each analysis day and after every 20 samples or hour of operation during the day. If the measured value falls outside the acceptance range the check sample must be reanalyzed; if it is still outside the acceptance range the instrument must be recalibrated and any samples analyzed since the previous acceptable calibration check must be reanalyzed.

At least one sample in each set of 20 must be analyzed in duplicate to assess measurement precision. Relative percent difference for duplicates should be ≤ 30%.

The field forms and field notes generated from this procedure will be reviewed by the sampling team leader, project manager, or designee. All quality control results must be downloaded to project computer files along with sample data. Any deviations from this POP, problems encountered during the analysis and corrective actions taken must be documented in the field records.

7.0 Data and Records Management

Unanticipated changes to the procedures or materials described in this POP (deviations) will be appropriately documented in the project records.

All data and spectral files must be backed up onto a computer on a regular basis. Any deviations from this POP or problems encountered during the analysis must be documented in a field log book which is dedicated to the XRF analyzer.

Records associated with the activities described in this POP will be maintained according to the specific document management policy for the project.

8.0 Personnel Qualifications and Training

8.1 Qualifications and training

The individual executing these procedures must have read, and be familiar with, the requirements of this POP.

Sampling personnel must be health and safety certified as specified by Occupational Safety and Health Administration (OSHA) 29 CFR 1910.120(e)(3)(i) to work on sites where hazardous materials may be present.

Each person who performs this procedure will undergo training offered by the manufacturer such that the procedure is performed in a consistent manner and all safety procedures are followed.

Individual states and countries have specific regulations and guidelines for the use of X-ray tube devices that produce ionizing radiation. For New Jersey site work, the licensing requirements outlined in N.J.A.C. 7:28-54.1 must be met prior to the start of site work.

8.2 Responsibilities

The project manager is responsible for providing the project team with the materials, resources and guidance necessary to properly execute the procedures described in this POP.

The individual performing the work is responsible for implementing the procedures as described in this POP and any project-specific work plans.

9.0 References

United States Environmental Protection Agency. 2001. Guidance for Preparing Standard Operating Procedures (SOPs). EPA QA/G-6. EPA/240/B-01/004. USEPA Office of Environmental Information, Washington, DC. March 2001.

United States Environmental Protection Agency. 2007. Method 6200, Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment, Revision 0. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Washington, D.C. January 2008.

New Jersey Department of Environmental Protection Site Remediation Program. 1994. Field Manual. Trenton, NJ. July 1994.

Thermo Scientific, Niton XL3t 600 Analyzer User’s Guide, Version 6.5. Billerica, MA 2009

Field Records – POP 101

1.0 Scope and Method Summary

This Project Operating Procedure (POP) provides guidance for documentation of field activities associated with AECOM Project operations, including, but not limited to; sample collection, field measurements, and groundwater monitoring well installation. Appropriate documentation of field activities provides an accurate and comprehensive record of the work performed, sufficient for a technical peer to reconstruct the day's activities and determine that necessary requirements were met. Field records also provide evidence and support technical interpretations and judgments. The procedures and systems defined in this POP help ensure that the records are identifiable (reference the project task/activity), legible, retrievable, and protected from loss or damage.

Project field data may be recorded electronically or in field logbooks, standardized forms, annotated maps, or photos. This POP provides general guidance on field recordkeeping; additional details for specific procedures (for example, chain of custody, sample collection) are provided in the POPs for the individual task.

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

2.0 Health and Safety

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

3.0 Interferences

Not Applicable.

4.0 Equipment and Supplies

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Bound field logbook (preferably waterproof, such as Rite-in-Rain™),
- Standardized field data sheets,
- Black or blue, ballpoint pen with indelible ink,
- Sharpie® (or equivalent permanent marker),
- Site maps,
- Clipboard,
- Three-ring binder or equivalent,
- Camera (optional),
- Time piece,
- Hand-held electronic recording device (such as Trimble Yuma®) (optional), and
- Laptop computer or tablet PC (optional).

5.0 Methods

5.1 General Requirements

- The field records will contain sufficient detail so that the collection effort can be reconstructed without reliance on the collector's memory.
- Pertinent field information will be recorded legibly in a logbook and/or an appropriate standardized form (as described herein). Entries should be made with a ballpoint pen with black or blue indelible ink or a

permanent marker. Pencils should not be used. If a ballpoint pen or permanent marker cannot be used because of adverse weather conditions (rain or freezing temperatures) and only a pencil can be used, an explanation must be included in the logbook and the affected data should be photocopied, signed as verified copy, and maintained in the project files as documentation that the data has not been changed.

- Entries will be signed and dated. No erasures or obliterations will be made. A single line strikeout will be drawn through incorrect entries and the corrected entry written next to the original strikeout. Strikeouts are to be initialed and dated by the originator.
- Entries will be factual and observational (i.e., no speculation or opinion), and will not contain any personal information or non-project-related entries. Abbreviations and acronyms should be defined.
- Field information will be recorded timely – information recorded significantly after the fact will be dated as such.
- Field activities and other events pertinent to the field activities will be documented in chronological order. Times will be recorded using military time or Eastern Standard Time.

5.2 Field Logbooks

The cover and binding of each logbook will be labeled to identify the operation and dates included with the logbook; each page in the logbook will be consecutively numbered. Pages will not be removed or torn out of the logbook.

The title page of each logbook will contain the following:

- AECOM contact, AECOM office location, and phone number;
- Project name and AECOM project number; and
- Start and end dates of work covered by the logbook.

At the front of each logbook will be a page cross-referencing each author's printed name, signature, and initials. A page header will appear on the first page of each day's notes in the logbook, and activities for each day will be recorded on a new page. The page header will include:

- Name of author and other personnel on site (and affiliated organization if applicable);
- Date;
- Time of arrival;
- Proposed activity (task); and
- Current weather and weather forecast for the day.

An abbreviated header, containing at least the date, authors name, and project number, will appear at the top of each additional page for the active date. Field forms require similar header information. The field logbook will provide a chronology of events. At a minimum, documentation in a logbook will include the following (unless documented on a standard form):

- Names of visitor(s), including time of arrival and departure, the visitor's affiliation, and reason for visit;
- Summary of project-related communications, including names of people involved and time;
- Time daily work commences and ceases;
- Start and stop times of new tasks;
- Start and stop times of significant stand-by time (work interruptions);
- Safety or other monitoring data, including units with each measurement;
- Deviations from approved scope of work, including the necessary approvals;
- Progress updates;
- Problems/delays encountered;
- Unusual events; and
- Signature or initials of author on last page of each day's event.

The logbook will cross-reference the field forms if necessary; however, whenever possible, details recorded on the standardized forms will not be replicated in the logbook.

If there are additional lines on the page at the end of the day's activities, a line will be drawn through the empty space, and initialed and dated, leaving no room for additional entries.

5.3 Standardized Forms

Standard forms for field data are provided in the electronic project files.

The information collected on any field form may alternately be collected electronically by a laptop computer or electronic handheld device as appropriate.

The following rules apply to the standardized forms:

- Each form will be signed and dated by the person completing the form.
- There will be no blank spaces on the form – unused spaces will have “not applicable” or “not available” explanations.

5.4 Maps and Drawings

Pre-existing maps and drawings that include notations made in the field (for example, relocating of sample locations) will be referenced in the logbook and, like all field records, include the project/task name and number, site identification, and be signed/dated by the person that prepared them.

Maps and drawings will include compass orientation and scale. Sketches will include points of reference and approximate distances to the reference points.

5.5 Photo Documentation

Photographs or videos may be taken by the field team to help document site conditions, sample locations, or sample characteristics. Photographs and videos will be identified in the logbook or on the standard form by a unique numbering system. If photographs are collected by a digital camera, the photograph number will accompany the description of the photograph in the logbook. At a minimum, the date/time the photograph was taken, the general location, a brief description, and the photographer’s name will be recorded. Additional information may include Global Positioning System (GPS) coordinates, direction the photographer was facing, and/or weather conditions. If necessary, an object will be included to indicate the scale of the object in the photograph.

5.6 Electronic Files

Electronically recording devices may include data logging systems, personal digital assistants (PDAs), laptops, tablet PCs, etc.

Sufficient backup systems will be in place to protect against electronic data loss. Information will be saved to a disk or backed up at the end of each day. The backup disk or other media (CD, flash drive) will then be stored in a secure location separate from the laptop, tablet, PDA, etc.

Files will be uniquely identified and will be stored in the project files on the network. An unedited version of the file will be maintained and all subsequent manipulations tracked.

6.0 Data and Records Management

Deviations to the procedures detailed in the POP or approved plans will be noted in the field logbook or other appropriate field form at the time of occurrence. Proposed modifications to the POPs or approved plans will be documented and submitted to the Task Manager.

Logbooks that are taken offsite from the field facility will be photocopied or scanned and filed to mitigate against the loss of historical entries should the logbook be lost in the field.

Field data forms and chain of custody will be filed in the field facility once they have been completed and distributed (if necessary), or at the end of each field day. These documents will be maintained in labeled three-ring binders or contained in some other organized manner that prevents loss. Distribution of daily forms will be performed according to the needs of the project team and at the direction of the Field Task Manager or designee.

7.0 Quality Assurance and Quality Control

Quality Control (QC) samples collected may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

8.0 Personnel Qualifications

It is the responsibility of the field personnel to be familiar with the procedures outlined in this POP. It is also the responsibility of the field personnel to be familiar with the procedures outlined within this *Sampling and Analysis Plan (SAP), the Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP).* Personnel who work on sites where hazardous waste materials may be present will be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29CFR 1910.120(e)(3)(i)).*

Chain of Custody Procedures – POP Number: 102

1.0 Scope and Method Summary

This POP describes the methods to be used for completing the chain of custody (COC) used in the collection of environmental samples. The National Enforcement Investigations Center of the United States Environmental Protection Agency (U.S. EPA) defines custody of evidence in the following manner:

- It is in your actual possession;
- It is in your view, after being in your physical possession;
- It was in your possession and then you locked or sealed it up to prevent tampering; or
- It is in a secure area.

2.0 Health and Safety Considerations

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, is addressed in the site specific Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

3.0 Equipment and Supplies

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Sample Labels,
- COC Form,
- Field Project Logbook,
- COC Tape or Custody Seals, and
- Pen with indelible ink and/or permanent marker.

4.0 Procedures

4.1 Sample Labeling

Labeling of samples occurs at the time of sample collection. Waterproof, adhesive labels are preferred. Labels should be applied to the container, not the lid whenever possible. Additional interior labels may be required for certain biological samples.

Labels should be completed in indelible ink. Covering the label with clear plastic tape is recommended to protect the legibility of the label and to prevent the label from detaching from the sample container.

The following information should be recorded on the sample label:

- Project Identification (project name and number/client/site),
- Field Sample Identification Number (exactly as it appears on the COC form),
- Sampler's Initials,
- Date and Time of Sample Collection,
- Analyses Requested, and
- Preservation.

4.2 Field Custody

The field personnel are required to complete the following information on the COC form:

- Project Number,

- Client or Project Name,
- Project Location,
- Page number (e.g., 1 of 2, 2 of 2, etc.),
- Laboratory name and address,
- Field Sample Identification Number,
- Date and Time of Sample Collection,
- Sample Matrix,
- Preservative,
- Analysis Requested,
- Sampler's Signature,
- Signature of Person Relinquishing Sample Custody,
- Date and Time Relinquished, and
- Sampler Remarks.

Hand-written COCs must be filled out completely and legibly in indelible ink. Corrections will be made, if necessary, by drawing a single line strikethrough and initialing and dating the error. The correct information is then recorded with indelible ink. If a correction is needed on a computer generated COC form, it must be corrected in the program from which it was created and reprinted. It cannot be corrected with a single line method. All transfers from field personnel to laboratory personnel are recorded on the COC form in the "Relinquished By" and "Received By" sections.

If samples are to be shipped by overnight commercial courier (e.g., Federal Express), the field personnel must complete a COC form for each package (e.g., cooler) of samples and place a copy of each completed form inside the associated package before the package is sealed. Each completed COC form must accurately list the sample identification numbers of the samples with which it is packaged. Alternately, a copy of the original COC form may be placed in each package. The copy of the COC form must at a minimum list the samples that are contained in the respective package. The original COC from must be included in one of the packages. It is not necessary for the shipping company to sign the COC. Sample packaging will be conducted in accordance with POP 103 – Packaging and Shipment of Environmental Samples.

If samples are hand carried to a laboratory, the person hand carrying the samples is the sample custodian. If the carrier is a different person than the one who filled out the COC form and packaged the samples, then that person must transfer custody to the carrier by signing and dating each form in the "Relinquished By" section. The carrier must then sign and date each form in the adjacent "Received By" section. When the carrier transfers the samples to the laboratory, he or she must sign and date each form in the next "Relinquished By" section, and the laboratory sample custodian must sign and date each form in the adjacent "Received By" section.

4.3 Laboratory Sample Receipt and Inspection

Upon sample receipt, the coolers or packages are inspected for general condition and the condition of the COC tape or custody seal. The coolers or boxes are then opened and each sample is inspected for damage.

Sample containers are removed from packing material and sample label field identification numbers are verified against the COC form.

The following information is recorded in the laboratory's records:

- Air Bill number (if appropriate),
- Presence/absence of COC forms,
- Condition of samples,
- Discrepancies noted,
- Holding time and preservatives, and
- Sample storage location.

The COC form is completed by signing and recording the date and time of receipt.

The Task Manager or designee must be notified of any breakage, temperature exceedance, or discrepancies between the COC paperwork and the samples.

5.0 Data and Records Management

The data associated with COC procedures is contained within the following:

- Sample labels,
- Chain of custody records and custody seal(s), and
- Sample collection records.

The following POPs describe the data collection and record management procedures that should be followed as part of the COC procedure:

POP 101 - Field Records, and

POP 103 - Packaging and Shipment of Environmental Samples.

See the referenced POPs for additional details.

6.0 Quality Assurance and Quality Control

The records generated in this procedure are subject to review during data validation, in accordance with the QAPP.

Quality Control (QC) samples collected may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

7.0 Personnel Qualifications and Training

Individuals responsible for completing COC documentation must be personnel working on the specific field program, have read this POP, and have worked under the oversight of experienced personnel. For certain sampling programs, the Project Manager, Task Manager, or designee may assign an individual to serve as sample custodian. This individual is responsible for supervising the implementation of COC procedures in accordance with this POP and any project-specific work plans or Quality Assurance Project Plan (QAPP).

Personnel who will work on sites where hazardous waste materials may be present will be health and safety certified as specified by OSHA (29 CFR 1910.120(e)(3)(i).

Packaging and Shipping – POP 103

1.0 Scope and Method Summary

This Project Operating Procedure (POP) describes the basic techniques and general considerations to be followed for the packaging and shipment of environmental samples consisting of water, soil, sediment and any other matrix sampled and submitted for routine environmental testing.

This POP is designed to provide a high degree of certainty that environmental samples will arrive at their destination intact. While the majority of the samples are delivered via laboratory courier, this POP assumes that samples will often require shipping overnight by a commercial carrier service; therefore, the procedures are more stringent than may be necessary.

Sample packaging and shipment involves the placement of individual sample containers into a cooler or other similar shipping container and placement of packing materials and coolant in such a manner as to isolate the samples, maintain the required temperature, and to limit the potential for damage to sample containers when the cooler is transported

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager and the Project QA Manager. Deviations from the POP will be documented in the project records and in subsequent reports. The ultimate procedure employed will be documented in the report summarizing the results of the sampling event or field activity.

2.0 Health and Safety

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, are addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

3.0 Interferences

Sample containers with presumed high constituent concentrations should be isolated within their own cooler with each sample container placed into a zipper-lock bag.

4.0 Equipment and Supplies

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Sample coolers,
- Sample containers,
- Shipping labels,
- Chain of custody (COC) form,
- Bubble wrap,
- Vermiculite (granular), or Styrofoam pellets,
- Wet ice,
- Temperature blank,
- Transparent tape,
- Custody seal for the outside of the cooler,

- Fiberglass packaging tape,
- Duct tape,
- Scissors,
- Zipper-lock plastic bags (gallon and quart sizes),
- Trash bags,
- Health and safety supplies (as required by the HASP), and
- Field project logbook/pen with indelible ink.

5.0 Methods

5.1 Preparation

The extent and nature of sample containerization will be governed by the type of sample, and the most reasonable projection of the sample's hazardous nature and constituents. *United States Environmental Protection Agency (U.S. EPA)* regulations (40 CFR Section 261.4(d)) specify that samples of solid waste, water, soil or air, collected for the sole purpose of testing, are exempt from regulation under RCRA when any of the following conditions are applicable:

- Samples are being transported to a laboratory for analysis;
- Samples are being transported to the collector from the laboratory after analysis;
- Samples are being stored (1) by the collector prior to shipment for analyses, (2) by the analytical laboratory prior to analyses, or (3) by the analytical laboratory after testing but prior to return of sample to the collector or pending the conclusion of a court case.

5.2 Sample Information

The following information must accompany each shipment of samples on a chain of custody form where each sample has an individual entry:

- Sample collector's name, mailing address and telephone number,
- Analytical laboratory's name, mailing address and telephone number,
- A unique identification of each sample,
- Sample description (matrix),
- Number and type of sample containers,
- Container size,
- Preservative,
- Type and method of analysis requested,
- Date and time of sample collection, and
- Special handling instructions, including notation of suspected high concentration samples.

5.3 Laboratory Notifications

Prior to sample collection, the Task Manager or designee must notify the laboratory project manager of the number, type, and approximate collection and shipment dates for the samples. If the number, type, or date of sample shipment changes due to program changes that may occur in the field, the Task Manager or alternate should notify the laboratory of the changes. Additional notification from the field is often necessary when shipments are scheduled for weekend delivery.

5.4 Cooler Inspection and Decontamination

Laboratories will often re-use coolers. Every cooler received at a project location should be inspected for condition and cleanliness. Any coolers that exhibit cracked interiors or exterior linings/panels or hinges should be discarded because the insulating properties of the coolers would be considered compromised. Any coolers missing one or both handles should also be discarded if replacement handles (i.e., knotted rope handles) cannot be fashioned in the field.

The interior and exterior of each cooler should be inspected for cleanliness before using it. Excess strapping tape and old shipping labels should be removed. If the cooler interior exhibits visible contamination or odors it should not be used. Drain plugs should be sealed with duct tape.

5.5 Sample Packaging

Place plastic bubble wrap matting over the base of each cooler or shipping container as needed. A 2- to 3-inch thick layer of vermiculite may be used as a substitute base material. Line the inside of the cooler using a large trash bag with the open end up.

Check that each sample container is sealed, labeled legibly, and is externally clean. Re-label and/or wipe bottles clean if necessary. Place all sample containers in bubble wrap bags and seal the bag using either the adhesive strip on the bag or tape. Place bottles into the cooler (inside the trash bag) in an upright single layer with approximately one inch of space between each bottle. Do not stack bottles or place them in the cooler lying on their side. If plastic and glass sample containers are used, alternate the placement of each type of container within the cooler so that glass bottles are not placed side by side if possible.

Insert the cooler temperature blank supplied by the laboratory into each cooler (if any).

If needed, place additional vermiculite, bubble wrap, and/or Styrofoam pellet packing material throughout the voids between sample containers within each cooler to a level that meets the approximate top of the sample containers. Packing material may require tamping by hand to reduce the potential for settling.

Bag wet ice into gallon-size zipper-lock bags to ensure no leaking occurs during shipment. Insert the bags of ice around, between, and on top of the sample containers. Sufficient ice should be used to maintain the sample temperature at 4° Celsius (C) during shipping. Close and seal the large trash bag that lines the cooler by twisting the open end and taping or knotting the bag closed to prevent the cooler from leaking throughout the shipping process.

Add additional bubble wrap/Styrofoam pellets or other packing materials to fill the balance of the cooler or container.

Complete the COC form per *POP 102 – Chain of Custody Procedures*. If shipping the samples involves use of a third party commercial carrier service, sign the COC record thereby relinquishing custody of the samples. Shippers should not be asked to sign COC records. If a laboratory courier is used, or if samples are transported to the laboratory by field personnel, the receiving party should accept custody and sign the COC records. Remove the last copy from the multi-form COC and retain it with other field notes. If an electronically produced COC is used, make copies of the COC (only after all signatures are in place). Place the original (with remaining copies) in a zipper-lock plastic bag and tape the bag to the inside lid of the cooler or shipping container.

Close the lid of the cooler or the top of the shipping container.

If shipping samples via third party commercial carrier service (e.g., FedEx), obtain COC tape or custody seals and enter the custody tape/seal number(s) in the appropriate place on the COC form. Sign and date the COC tape/seals. If the samples are being transported via laboratory courier, COC tape or custody seals are not required.

When placing COC tape or a signed and dated custody seal on the cooler, place it with half of the seal on the lid and the other half on the body of the cooler.

Packaging tape should be placed entirely around the sample shipment containers. A minimum of two full wraps of packaging tape will be placed at least two places on the cooler/container. The custody seal should be underneath one of the wraps of packaging tape.

Repeat the above steps for each cooler or shipping container.

5.6 Sample Shipping

Transport the cooler/container to the package delivery service office or arrange for package pick-up at the site. Fill out the appropriate shipping form or air bill and affix it to the cooler/container. The shipper should consider an “up arrow” label to direct proper placement of the cooler when set. Some courier services may use multi-package shipping forms where only one form needs to be filled out for all packages going to the same destination. However, separate shipping form should be used for each cooler/container, the multi-package shipping forms should not be used when shipping environmental samples. The receipt for package tracking purposes should be kept in the project files, in the event a package becomes lost.

Each cooler/container also requires a shipping label that indicates point of origin and destination. This will aid in recovery of a lost cooler/container if a shipping form gets misplaced.

Never leave coolers/containers unattended while waiting for package pick-up.

Air bills or way bills will be maintained as part of the custody documentation in the project files.

5.7 Sample Receipt

Upon receipt of the samples, the analytical laboratory will open the cooler or shipping container and will sign "received by laboratory" on each COC form. The laboratory will verify that the COC tape has not been broken previously and that the COC tape/seal number corresponds with the number on the COC record. The laboratory will note the condition of the samples upon receipt and will identify any discrepancies between the contents of the cooler/container and COC. The analytical laboratory will then forward the back copy of the COC record to the project Quality Assurance (QA) Officer to indicate that sample transmittal is complete.

6.0 Data & Records Management

The data associated with packaging and shipment of environmental samples is contained within the following:

- Sample labels,
- Chain of custody records and custody seal(s),
- Field logbook, and
- Sample collection records.

The following POPs describe the data collection and record management procedures that should be followed as part of the packaging and shipment of environmental samples process:

- *POP 101 Field Records, and*
- *POP 102 Chain of Custody Procedures.*

See the referenced POPs for additional details.

7.0 Quality Control and Quality Assurance

Quality Control (QC) samples used in association with packaging and shipment of environmental samples include trip blanks and temperature blanks. See the QAPP for frequency of use and methods.

8.0 Personnel Qualifications

Sample packaging and shipment is a relatively simple procedure requiring minimal training and a minimal amount of equipment. It is recommended that initial attempts be supervised by more experienced personnel.

Personnel who will work on sites where hazardous waste materials may be present will be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)).*

It is the responsibility of the field personnel to be familiar with the procedures outlined within this POP, quality assurance, and health and safety requirements outlined within this *Sampling and Analysis Plan (SAP)*, the *Quality Assurance Project Plan (QAPP)*, and the *Health and Safety Plan (HASP)*. Field personnel are also responsible for proper documentation in the field logbook.

9.0 References

POP 101 – Field Records

POP 102 – Chain of Custody Procedures

Decontamination of Field Equipment – POP Number: 105

1.0 Scope and Method Summary

This Project Operating Procedure (POP) describes the methods to be used for the decontamination of field equipment used in the collection of environmental samples. Field equipment for decontamination may include a variety of items used in the field for monitoring or for collection of soil, sediment, and/or water samples, such as water level meters, water quality monitoring meters (turbidity meter, multi-parameter meter), split-spoon samplers, trowels, scoops, spoons, and pumps. Heavy equipment such as a drill rig also requires decontamination, usually in a specially constructed temporary decontamination area.

Decontamination is performed as a quality assurance measure and a safety precaution. Improperly decontaminated sampling equipment can lead to misinterpretation of environmental data due to interference caused by cross-contamination between samples or sample locations through use of contaminated equipment. Decontamination also protects field personnel from potential exposure to hazardous materials on equipment.

Decontamination is accomplished by manually scrubbing, washing, or spraying equipment with detergent solutions, tap water, distilled/deionized water, and/or solvents.

Generally, decontamination of equipment is accomplished at each sampling site between collection points. Waste decontamination materials such as spent liquids and solids will be collected and managed as investigation derived waste (IDW) for later management and/or disposal (refer to procedures outlined POP 106 (Investigative Derived Waste Management)).

This POP emphasizes decontamination procedures to be used for decontamination of reusable field equipment. Dedicated or disposable equipment will not be decontaminated.

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

2.0 Health and Safety Considerations

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

3.0 Interferences

Equipment decontamination should be performed at a safe distance away from the sampling area so as not to interfere with sampling activities, but close enough to the sampling area to maintain an efficient working environment.

4.0 Equipment and Supplies

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Decontamination agents;
    - ALCONOX®, or other non-phosphate and non-borate biodegradable detergent,
    - Tap water, and
    - Distilled/deionized water.
- Health and safety supplies (as required by the HASP);
- Chemical-free paper towels;
- Waste storage containers: drums, 5-gallon buckets with covers, plastic bags;
- Cleaning containers: plastic buckets or tubs ;

- Cleaning brushes;
- Pressure sprayers;
- Squeeze/spray bottles;
- Plastic sheeting;
- Zipper-lock bags and/or foil wrap; and
- Field project logbook/pen with indelible ink.

5.0 Procedures

5.1 General Preparation

New materials, such as well materials, are generally assumed to be clean and decontamination is not anticipated. However, they should be inspected and if they appear to be dirty, should be decontaminated.

Field equipment should be inspected and decontaminated prior to use if the equipment appears dirty.

Heavy equipment (drill rigs, Geoprobes®, excavators) should be decontaminated prior to beginning any work.

Pre-established IDW containment stations should be used to discard IDW between sampling locations.

5.2 Decontamination for Sampling Equipment

This procedure applies to equipment used in the collection of environmental samples and other field equipment. Examples of relevant items of equipment include split-spoons, trowels, scoops, spoons, and other small items. Submersible pump decontamination procedures are outlined in Section 5.3.

- Decontamination is to be performed before sampling events, between sampling points, and at the end of the day unless otherwise noted in the work plan. After a sample has been collected, remove all gross contamination from the equipment or material by brushing and then rinsing with available tap water. This initial step may be completed using a 5-gallon bucket filled with tap water or by spraying/pouring tap water over the equipment in to a bucket. A water pressure sprayer may also be used to remove solids and/or other contamination.
- Wash the equipment with a non-phosphate and non-borate detergent and tap water solution. This solution should be kept in a 5-gallon bucket with a dedicated brush. Isopropyl alcohol may also be used to remove any contamination that may not be easily removed with detergents. If isopropyl alcohol is used, the equipment must be washed again using a detergent.
- Rinse with tap water or distilled/deionized water until all detergent and other residue is washed away. This step can be performed over an empty bucket using a squeeze bottle, pressure sprayer or by directly pouring the distilled/deionized water over the equipment.
- Place the equipment on a clean surface (foil or plastic) and allow the equipment to air-dry in a clean area or blot with chemical-free paper towels before reuse. All decontaminated equipment should be placed in a clean plastic bag, clean pail, or wrapped in foil once it is dry if it is being stored.
- Dispose of soiled materials and spent solutions in the designated IDW disposal containers.

5.3 Decontamination of Submersible Pumps

This procedure will be used to decontaminate submersible pumps before and between groundwater sample collection points. This procedure applies to both electric submersible and bladder pumps. This procedure also applies to discharge tubing if it will be reused between sampling points.

- Prepare the decontamination area if pump decontamination will be conducted next to the sampling point. If decontamination will occur at another location, the pump and tubing may be removed from the well and placed into a clean trash bag for transport to the decontamination area.
- Once the decontamination station is established, the pump should be removed from the well and the discharge tubing and power cord coiled by hand as the equipment is removed. If any of the equipment needs to be put down temporarily, it should be placed on a plastic sheet (around well) or in a clean trash bag. If a disposable discharge line is used it should be removed and discarded at this time.
- As a first step in the decontamination procedure, use a pressure sprayer with tap water to rinse the exterior of the pump, discharge line, and power cord as necessary. Collect the rinsate and handle as IDW.

- Place the pump into a bucket containing a detergent solution (phosphate-free, borate-free detergent in tap water). Holding the tubing/power cord, pump solution through the pump system. A minimum of one gallon of detergent solution should be pumped through the system. Collect the rinsate and handle as IDW.
- Remove the pump from the bucket and if the pump is reversible, place the pump in the reverse mode to discharge all removable water from the system. If the pump is not reversible the pump and discharge line should be drained by hand as much as possible. Collect the rinsate and handle as IDW.
- Place the pump into a clean bucket containing distilled/deionized water. Holding the tubing/power cord, pump the distilled/deionized water through the pump and tubing to remove any detergent residue that may remain inside the pump and tubing. Using a pressure sprayer with distilled/deionized water, rinse the exterior of the pump, discharge line, and power cord thoroughly, shake off all excess water, and then place the pump system into a clean trash bag for storage. Collect the rinsate and handle as IDW.

5.4 Decontamination of Large Equipment

A temporary decontamination pad may be established for decontamination of heavy equipment. This pad may include a membrane-lined and bermed area large enough to drive heavy equipment (e.g., drill rig, backhoe) onto with enough space to spread equipment and to contain overspray. Usually a small sump is necessary to collect and contain rinsate (a pump is used to remove these wastes from the sump). A water supply and power source is also necessary to run steam cleaning and/or pressure washing equipment.

Upon arrival at the area of investigation, all heavy equipment (such as drill rigs) should be thoroughly cleaned. This can be accomplished by steam cleaning or high pressure water wash and manual scrubbing.

Between each sample location (i.e., between boreholes), heavy equipment that has been in the ground must be cleaned by steam cleaning or high pressure water wash and manual scrubbing. This may be performed at the decontamination pad or in the vicinity of the drilling location.

6.0 Data and Records Management

The data associated with decontamination procedures includes the following:

- Date, time, and location of each decontamination event,
- Equipment decontaminated,
- Method,
- Detergents used,
- Notable circumstances,
- Identification of equipment rinsate blanks,
- Management of decontamination fluids,
- Method, date, and time of equipment blank collection, and
- Disposition of IDW.

Repetitive decontamination of small items of equipment does not need to be logged each time the item is cleaned.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

7.0 Quality Assurance and Quality Control

Quality Control (QC) samples collected in association with decontamination of field equipment may include equipment rinsate blanks. See the QAPP for collection frequency and methods.

8.0 Personnel Qualifications and Training

Decontamination of field equipment is a relatively simple procedure requiring minimal training.

Field personnel must be health and safety certified as specified by Occupational Health and Safety Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous materials may be present.

It is the responsibility of field personnel to be familiar with the decontamination procedures outlined within this POP, quality assurance, and health and safety requirements outlined within this Sampling and Analysis Plan (SAP), the Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP). Field personnel are responsible for decontamination of field equipment and for proper documentation in the field logbook or electronic data collector such as the Trimble Yuma® (or equivalent).

9.0 Reference

POP 106 – Investigative Derived Waste Management.

Investigative Derived Waste Management – POP 106

1.0 Scope and Method Summary

This Project Operating Procedure (POP) describes the methods to be used for the collection, containerization, transport, and disposal of waste generated during AECOM field investigations. Types of investigation-derived waste (IDW) may include, but are not limited to, personal protective equipment (PPE); disposable sampling equipment; purge water generated from wells during monitoring events; well development water; extra sample volume not required for analysis in the form of soil, sediment or water; soil cuttings from the installation of wells or soil borings; decontamination fluids, etc.

IDW management is accomplished by appropriately containing, collecting, packaging, characterizing and disposing of the waste. The following guidance documents were used in the development of this POP:

- *REM III Program Guidelines, Field Technical Guidelines 12.02 (United States Environmental Protection Agency (U.S. EPA), 1987)*
- *Management of Investigation-Derived Waste During Site Inspections (U.S. EPA, 1991a)*
- *Standard Operating Procedures and Quality Assurance Manual, Section 4.5 (U.S. EPA, 1991b)*

It is expected that the procedures outlined in this POP will be followed by all personnel during activities that generate and/or manage IDW. Procedural modifications may be warranted depending on field conditions, equipment limitations or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

2.0 Health and Safety

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

3.0 Interferences

Not Applicable.

4.0 Equipment and Supplies

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Sample kit (i.e., bottles, labels, preservatives, custody records and tape, cooler, ice),
- Sample chain of custody forms (as required by *POP 102 – Chain of Custody Procedures*),
- Sample packaging and shipping supplies (as required by *POP 103 – Packaging and Shipment of Environmental Samples*),
- Drum labels,
- Waterproof marker or paint,
- Paper towels,
- Trash bags,
- Health and safety supplies (as required by the HASP),
- Field logbook and pen,
- Drums, tubs, totes, and other receptacles used to contain IDW, and
- Drum bung wrench, drum lid ring’s deep well socket and socket wrench.

5.0 Methods

In the process of collecting environmental samples during field investigation activities, many different types of IDW may be generated. Some of these waste materials may be hazardous wastes which must be properly managed in accordance with U.S. EPA and state regulations. To properly handle IDW in compliance with agency regulations, reasonable efforts should be made to characterize the wastes as non-hazardous or hazardous and to determine if the IDW has been mixed with a listed waste.

Resource Conservation and Recovery Act (RCRA) procedures for determining whether a waste exhibits RCRA hazardous characteristics do not require sampling and analysis if the decision can be made by “applying knowledge of the hazard characteristic in light of the materials or process used” (40 CFR 262.11(c)). The nature of the waste should be assessed by applying best professional judgment and using readily available information about the site (such as manifests, storage records, preliminary assessments, and results of earlier studies that may have been conducted and are available, as well as direct observation of the IDW for discoloration, or other indicators of contamination). The U.S. EPA has specifically indicated that IDW may be assumed to not be a “listed” waste under RCRA unless available information about the site suggests otherwise.

5.1 General

Upon designating IDW as either RCRA hazardous or RCRA non-hazardous using existing information and best professional judgment practices, the Task Manager should assure that appropriate handling procedures have been developed.

5.2 Management of Non-Hazardous IDW

Non-hazardous IDW such as PPE and disposable equipment may be bagged and transported to a local permitted municipal landfill. Non-hazardous IDW such as drill cuttings, purge or development water, decontamination fluids, etc., will be containerized, managed appropriately while on site, and transported to an appropriately licensed off-site disposal facility. Waste hauling services should be obtained and waste storage locations maintained at the project site pending transport.

Purge water from monitoring wells which have already been analyzed and are shown to be below Residential Drinking Water Criteria may be discharged to the ground surface away from the monitoring well unless otherwise prohibited by site protocol.

Purge water from private potable wells which are in use may be discharged directly to the ground surface.

5.3 Management of Hazardous IDW

Hazardous IDW must be managed as specified in applicable U.S. EPA and state regulations. Management of hazardous waste includes both proper handling and disposal within the required time frame in accordance with requirements for small or large quantity generators, as applicable. IDW should be disposed off- site in an appropriately licensed and approved hazardous waste landfill or liquid waste treatment facility. IDW designated for off-site disposal must be properly containerized, characterized, labeled, and stored before transport and disposal.

On-site management of hazardous IDW requires special precautions and planning.

Generation of hazardous IDW should be kept to a minimum. Disposable equipment and PPE can often be cleaned to render it non-hazardous. Decontaminated PPE and disposable equipment should be bagged if sent to an off-site dumpster or a municipal landfill.

5.4 Waste Segregation

If it is determined by the Field Manager that off-site disposal of IDW is required, liquid waste should be contained separately from solid waste for ease of handling. For this POP, liquid wastes include purge and well development water, while solid wastes include soil, drilling mud, and sampling debris. If drums are used for containing the IDW, the Field Sampling Team Leader is responsible for noting in the field logbook, the waste type in each drum and for labeling the drums.

5.5 Solids

Solid waste to be containerized should be placed in Department of Transportation (DOT)-specified, 17H 55-gallon drums (or similar), lined roll off boxes or an appropriately constructed containment building. Under no circumstances should solid residues from a known “hot spot” be combined with other residues containing suspected but unknown contamination, regardless of whether the drum is filled or not. To minimize the number of drums (if used), “hot spot” residues containing similar waste characteristics can be combined. Also, for the collection of solid waste, allow at least 6 to 12 inches of empty space in each drum if the addition of absorbent is necessary. The following solid matter should be handled as described:

- Soil Cuttings/Excess Soil/Sediment Sample Volume - Soil cuttings or excess soil/sediment volume may be placed in DOT-specified drums, or placed in roll-off boxes or other containers pending transportation. Drums containing soil or sediment should be identified with a particular boring, well, or test pit from which the material was generated. To minimize the number of drums generated during an investigation, soils from several sources in the same general location can be placed in the same drum with proper labeling. Documentation must be maintained to identify the source of the soils (including boring ID and depths) containerized in a particular drum for correlation to laboratory data for future disposal. The description of the waste/soil, boring location, and general observations should also be noted in the field logbook. Soil cuttings from soil borings or well installation activities and sediment associated with sampling efforts will be containerized, labeled, staged for disposal, characterized, and disposed of at an appropriately licensed disposal facility.
- PPE, Sampling Equipment, and Absorbents - Used PPE and disposable sampling equipment can be containerized together but separate from other solid (soil/sediment) and liquid waste. Spent PPE and sampling equipment are typically collected on a daily basis in plastic garbage bags and disposed at the end of daily activities in a drum dedicated for this type of waste or in an on-site dumpster. Non-contaminated PPE and materials that do not come in contact with contaminated media can be disposed along with other general waste generated at the site. Soiled absorbents and PPE will be held in drums or roll-off boxes at the major centers of activity on the site or will be containerized, labeled, staged for disposal, characterized, and disposed of at an appropriately licensed disposal facility.

5.6 Liquids

For this POP, liquid waste refers to well development water, purge water and decontamination fluids. Liquid wastes requiring off-site transport and disposal can be containerized using 55-gallon drums, plastic totes, welded tanks, or liquid tanker trucks. The following liquids should be handled as described:

- Well Purge Water - Well purge water, which includes development and sampling purge water, if drummed, should be containerized separately from solid waste. Proper documentation shall be maintained to ensure that liquid waste containers specify the source of the purge water in order to correlate representative laboratory analyses with waste contained in a particular drum or container. It is acceptable to mix purge water from different wells, provided that proper documentation is maintained. However, the water quality results of the most contaminated well contributing to the mixed water will determine the proper method of disposal.
- Decontamination Water and Sample Preservatives - Decontamination water that includes chemicals used in the decontamination process, such as isopropyl alcohol or hexane, and excess sample preservatives should be containerized separately. Decontamination water is typically collected and disposed of as necessary in a drum(s) dedicated for this type of waste. Steam cleaning rinsate should also be containerized separately from other liquids unless the Field Manager determines that the rinsate is non-hazardous.
- Water generated during well development, well sampling, or decontamination processes will be containerized, labeled, staged, and transported to an appropriately licensed disposal facility.

5.7 On-Site Drum Handling

All filled or partially filled drums must be properly closed, sealed, labeled, and staged before demobilization. If storage is anticipated in excess of two weeks, the drums should be covered with a wind/rain resistant cover such as a plastic or polyethylene tarp.

5.8 Absorbent

Soil cuttings that have been containerized will frequently develop a layer of water after being stored on-site for a period of time. If fluids are present in the drums, an absorbent material may be added prior to removal offsite to prevent accidental spillage. This absorbent material can be added during site operations. The absorbing material should consist of an innocuous material such as vermiculite, sawdust, (or fine wood shavings), or some type of kitty litter. The absorbent should be added on the top of the solid waste and not mixed into the waste since the disposal facility may wish to separate the generated solids from the absorbed liquid. The depth and volume or weight of absorbent should be noted in the field logbook.

5.9 Staging

All drums shall be staged in a location designated by the Field Manager and approved, in advance, by the Project Manager. Depending upon the accessibility of the site to non-authorized individuals, the staging area may need to be fenced or located inside a larger fenced area. All drums shall be stored on pallets (if possible) in an area where they will stay dry in the case of heavy rain or ponding of water. The drums should be arranged in rows with adequate space between the rows to allow for visual inspection of all drums. The staging area should also be laid out by grouping drums of similar waste together to allow for easier access to waste types during the removal operations, minimizing the need to rearrange drums. Drums should not be stacked on top of each.

Equipment used to move filled drums may include backhoes, forklifts, front-end loaders or drum grapplers operated by qualified and trained personnel. Caution should be exercised to prevent damaging drums. Any drums found to be damaged or leaking must be overpacked in a leak-proof container.

In the event that drums must be stored on-site for longer than 90 days, precautions such as berms, secondary containment, and/or overpacking should be taken to prevent accidental leakage or environmental corrosion.

5.10 Sealing

Proper sealing involves securing and fastening drum rings and bungs. Open-top drums are delivered with the outer ring reversed and fastened with the bolt on the upper side of the drum lid, which is a universal convention indicating an empty drum. When the drums are filled, the drum lid should be secured by placing the ring with the bolt down and tightened over the drum lip. Depending on the access of the site to unauthorized individuals, it may be appropriate to notch or mark the drum and ring to assist in determining whether stored, unsecured drums have been opened. If a drum needs to be opened after sealing, appropriate personal protection shall be required.

5.11 Labeling

Initial labeling of all drums shall be performed through the use of an indelible marker on the top and the side of the drum (i.e., grease pens, Rust-Oleum brand or similar spray paint) or by placing a “Pending Analysis” label on the drum. The markings should be at least one inch in height and consist of a number that will allow the drum to be cross-referenced with the field logbook and include type of contents and generation date.

Upon receipt of the sample characterization analyses, final labeling of the drums will occur in accordance with applicable state and U.S. EPA requirements and AECOM policy. Factory-purchased labels will be utilized that provides space for the following information:

- Site name and drum log number,
- Material description (soil, sludge, etc.) and generation location (i.e., boring SB2),
- Generator’s name and address,
- Generator’s temporary ID number,
- Waste classification (hazardous or non-hazardous)
- DOT shipping name if hazardous
- Date generated, and
- Manifest or Bill of Lading number (if known).

Waste characterized as hazardous will require a Hazardous Waste label, U.S. EPA generator ID number, and proper transportation manifesting prior to transportation to an approved hazardous waste landfill or treatment facility. Drummed waste shown to be non-hazardous should be returned to the site proper and the drum either returned to the manufacturer (if possible) or properly disposed within the federal, state and local regulations.

5.12 Waste Classification

Prior to removal from a site, all waste must be classified to determine appropriate disposal procedures. Analytical data specifically relating to the drum contents can be used to determine the waste classification. Careful separation of wastes and proper documentation of drum contents may prevent the need for drum sampling if prior waste characterization sampling from the site is available. Additionally, analytical results of samples collected from the site and generator knowledge may also be used to classify waste as hazardous or non-hazardous. The official waste profile should be signed by the generator. The waste disposal facility may also perform their sampling, some of which might be performed on-site prior to removal.

5.13 Drum Removal & Disposal

Drummed wastes will be disposed at an appropriate disposal or treatment facility based upon characterization of the waste. Removal of wastes in drums from a site should be performed only by subcontractors holding permits approved by federal and state authorities to transport hazardous materials. In most cases, the various categories of wastes will be transported to one of several destinations. It is the responsibility of the Project Manager to determine that wastes are properly classified and to know their final destination. Furthermore, the Field Manager must inform the Project Manager of the wastes' final destination and secure from the client written concurrence on use of the disposal facility (through signature of the waste profile sheet). Although it is not required, subcontractors may be used to complete the waste profile sheets, classify the waste, perform confirmatory drum sampling, inspect/overpack (if necessary), and complete transportation manifest forms. The manifest forms should be signed by the client or by an authorized representative of the client.

6.0 Data & Records Management

The data associated with waste characterization includes the following:

- Location, date, and time of waste generation,
- Process which generated the waste,
- Assumed contaminants of concern within waste stream based upon current knowledge,
- Sample(s) collected with associated analytical parameter request,
- Sample ID's,
- Date and time of sample collection,
- Name of person collecting sample(s), and
- Chain of custody(s).

Upon receipt of waste classification results, appropriate transportation and disposal events should occur. The following information should be logged when preparing shipments for transport and disposal:

- Number, type, and quantity of containers being shipped,
- Current storage location(s) of containers,
- Waste approval number,
- Transporter (company) name and ID number,
- Manifest number, and
- Disposal facility name and location.

Certificates of Disposal and waste manifests shall be retained in accordance with EPA RCRA regulations and provided to the identified generator. The records generated in this POP will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

7.0 Personnel Qualifications

The management of IDW is a relatively involved procedure requiring specific training. Personnel trained in the containment, characterization, transport and disposal of IDW will oversee IDW management on this project. Additional training and/or certifications may be required if the IDW is characterized as hazardous.

Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i))* to work on sites where hazardous materials may be present.

It is the responsibility of field personnel to be familiar with the IDW management procedures outlined within this POP as well as quality assurance and health and safety requirements outlined within this *Sampling and Analysis Plan (SAP),* the *Quality Assurance Project Plan (QAPP), and the site-specific Health and Safety Plan (HASP)*.

8.0 Quality Assurance and Quality Control

Quality Control (QC) samples collected may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

9.0 References

Environmental Protection Agency, 1987, REM III Program Guidelines, Field Technical Guidelines 12.02, Region II.

Environmental Protection Agency, 1991a, Management of Investigation-Derived Waste During Site Inspections, Office of Research and Development, Washington, DC.

Environmental Protection Agency, 1991b, Standard Operating Procedures and Quality Assurance Manual (Section 4.5), Environmental Compliance Branch, Region IV, Athens, Georgia.

POP 102 – Chain of Custody

POP 103 – Packaging and Shipment of Environmental Samples

Surface Water Sample Collection – POP Number: 201

1.0 Scope and Method Summary

This POP describes the basic techniques and general considerations to be followed for the collection of surface water samples from streams, rivers, ponds, and lakes.

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans as appropriate and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

Surface water sample collection generally involves collection of a representative water sample from a water body (e.g., stream, river, pond, or lake) into an appropriate container. Specific field conditions such as water depth, tidal information, and location are recorded. Field parameters (e.g., pH, specific conductivity, water level collection from a stream gage, dissolved oxygen (DO), turbidity, oxidation-reduction potential (ORP), and temperature) will be monitored during surface water sample collection if stated in the work plan.

2.0 Health and Safety Considerations

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

3.0 Interferences

Potential interferences could result from cross-contamination between sample locations or entrainment of non-target material in the samples. Minimization of cross-contamination will occur through the following:

- Collection of samples from downstream to upstream locations (as appropriate);
- Collection of surface water samples prior to sediment samples at individual locations (when applicable);
- The use of clean, decontaminated sampling equipment at each location; and
- Avoidance of material (e.g., re-suspended solids) that is not representative of the medium to be sampled.

4.0 Equipment and Supplies

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Surface Water Sample Collection Record, field logbook, or electronic data collector,
- Sample chain of custody forms,
- Sample packaging and shipping supplies,
- Equipment decontamination supplies,
- Peristaltic pump,
- Disposable tubing (both for the pump head assembly and for sample collection as appropriate)
- Health and safety supplies (as required by the HASP),
- Waterproof marker pens (Sharpie® or equivalent),
- Rubber boots (waders),

- Individual or multi-parameter meter(s) to measure temperature, pH, specific conductance, DO, ORP, and/or turbidity (if appropriate),
- Instrument calibration solutions and calibration log,
- Water level meter
- Sample kit (i.e., bottles, sample bottle holders, labels, preservatives, custody records, custody seals, cooler, and ice),
- Tide chart, and
- Field notebook/pen.

5.0 Procedures

5.1 Access to Sample Locations

Sample locations are presented in each specific work plan. Where samples are located near bridges or piers, these structures can provide convenient access for sampling. A boat may be needed to sample locations on lakes/impoundments, as well as some locations on the Anacostia River. When boats are used for sampling, health and safety procedures as described in the HASP must be followed. Wading to locations may be considered, but is not the preferred method in the Anacostia River. If it is necessary to wade into the water body to obtain a sample, the sampler shall take care to minimize disturbance of bottom sediments and must enter the water body downstream of the sampling location. If sediment in the sample area is disturbed and water becomes turbid, the sampling technician shall wait for the sediments to settle before taking a surface water sample.

Under ideal and uniform constituent dispersion conditions in a flowing stream, the same concentration of each constituent would occur at all points along the cross section. This situation is most likely near the centroid of flow and away from tributary, eddy, or backwater confluences (USGS, 2006). Careful selection of the sample collection location should assure, as nearly as possible, that samples are taken where uniform flow or dispersion and good mixing conditions exist.

5.2 Surface Water Sampling

Surface water sampling procedures were adapted from USGS (2006) and modified for site-specific conditions. Surface water samples from the Anacostia River will be collected using a peristaltic pump and disposable tubing. A new length of tubing will be used for every location sampled. If necessary the tubing may be attached to an extension pole and lowered into the water column to the target depth. For surface water samples collected on the Anacostia River the general target depth is zero to one foot (ft) below the water surface unless otherwise specified in the work plan. Care should be taken to ensure that the intake end of the sample tubing does not contact the bed of the river, lake, stream, or pond to minimize the turbidity of the sample. The intake end of the tubing should also not contact the boat (if sampling from a boat) or any other potentially contaminated surface to avoid cross contamination. Air will be purged from the tubing prior to sample collection and field parameter readings. Sample containers will be filled in the order of analysis starting with the most volatile compounds with the metals being collected last. To minimize volatilization, the pump will be operated at a low speed for several minutes to slowly fill the tube with water which will then be drained to the volatile organic compound sample containers. The pump's speed may be increased to fill the remaining sample containers, provided the pumping rate does not induce turbidity. Water quality indicator parameter readings (e.g. pH, specific conductance, DO, ORP) will be recorded at the time of sample collection.

During cold weather months a peristaltic pump may become difficult or impossible to use, since the disposable tubing may freeze and portions of the river may be frozen over. A dipping method may be used during these months to help facilitate the sampling and maintain a safe work environment. Using an extension pole with a swing sampler attached, insert a clean one liter glass sample container (no cap is required) into the swing sampler and secure it with zip-ties. A weight attached to a long rope may be needed to break a hole in the ice large enough to fit the swing sampler through. Standing a safe distance from the river bank, extend the pole to the appropriate length and dip the swing sampler to the targeted sample depth (0-1 ft). Once the sample container is full, lift the pole and swing it back to the river bank. Carefully decant the surface water into the appropriate sample containers starting with most volatile compounds using caution to not displace preservatives if pre-preserved and collect the metals last. A new 1 liter sample container for dipping should be used at every location. The end of the extension pole with the attached swing sampler should be decontaminated in accordance with POP 105 between sample locations.

Samples will be collected farthest downstream first, moving upstream so as to minimize the potential influence on water quality caused by disturbance within the water body.

At each sample location, measurements for pH, specific conductivity, temperature, DO, ORP, and/or turbidity will be collected using either an individual or a multi-parameter meter. The depth of water, depth of sample collection, and visual observations including presence and/or absence of oil or oil sheen of the location will be recorded in the field documentation. At some locations, it will not be possible to measure all field parameters if safe work conditions do not allow – examples include measuring depth of water from a bridge near a dam overflow structure. Tidal information should also be recorded per current tide charts and/or as recorded from gauging a stream gage

A portion of the water sample may be filtered in the field prior to preservation for analysis in the laboratory of dissolved fractions (e.g., selected metals). Filtration procedures and equipment (e.g., vacuum filtration, pressure filtration through cartridge) will be determined by the volume of filtrate desired, presence of fine particulates (e.g., silts, clays) and best professional judgment. Selected filtration methods will be described on the sample collection form, field logbook, and/or electronic data collector.

5.3 Sample Handling and Preservation

Once each sample container is filled, cap and label the container with (at a minimum) the sample identifier, sampler's initials, sampling date and sampling time. Additional information such as preservation information and analytical tests will be added to the sample label as appropriate.

For samples slated for VOC analysis, confirm that no headspace bubbles are present in the sample container following placement of the cap. If bubbles are observed, recollect the sample.

Place the sample containers into a cooler and maintain on ice.

Complete sample chain of custody and other documentation per POP 102 – Chain of Custody Procedures.

Package the samples for shipment to the laboratory per POP 103 – Packaging and Shipment of Environmental Samples.

5.4 Equipment Decontamination

Decontamination is necessary for surface water sampling when using the dipping method described above, for water quality instrumentation, and for any other non-disposable equipment used during the surface water sampling process. When equipment decontamination is required POP 105 - Decontamination of Field Equipment will be followed

6.0 Quality Assurance / Quality Control

An energy calibration check should be run at the start of each day of sampling. This check confirms that the characteristic x-ray lines are stable and instrument drift is not occurring. This also provides a gain check if the ambient temperature fluctuates significantly. This test must be run at the start of each day, when the batteries are changed, when the instrument is shut down, and at the end of each day. This procedure should also be run any time the operator believes that drift is occurring during analysis.

A blank consisting of silicon dioxide or a Teflon or quartz block must be run at the beginning and end of each day of analysis and after every 20 samples or every hour of operation during the day or at any time the analyst suspects contamination in the analytical system.

An independent standard must be used to verify the accuracy of the instrument and confirm its stability and consistency for the analyte of interest. NIST, USGS or commercial standards may be used. The standard check must be performed at the beginning and end of each analysis day and after every 20 samples or hour of operation during the day. If the measured value falls outside the acceptance range the check sample must be reanalyzed; if it is still outside the acceptance range the instrument must be recalibrated and any samples analyzed since the previous acceptable calibration check must be reanalyzed.

At least one sample in each set of 20 must be analyzed in duplicate to assess measurement precision. Relative percent difference for duplicates should be ≤ 30%.

The field forms and field notes generated from this procedure will be reviewed by the sampling team leader, project manager, or designee. All quality control results must be downloaded to project computer files along with sample data. Any deviations from this POP, problems encountered during the analysis and corrective actions taken must be documented in the field records.

7.0 Data and Records Management

The data associated with surface water sample collection may contain the following:

- Sample labels,
- Chain of custody records and custody seal(s),
- Field logbook,
- Sample collection records,
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following POPs describe the data collection and record management procedures that should be followed as part of the surface water sample collection process:

POP 101	*Field Records,*
POP 102	*Chain of Custody Procedures,*
POP 103	*Packaging and Shipment of Environmental Samples, and*
POP 502	*Water Quality Instrumentation.*

See the referenced POPs for additional details.

8.0 Personnel Qualifications and Training

Surface water sample collection is a relatively involved procedure requiring formal training and a variety of equipment. It is recommended that initial sampling be supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous materials may be present.

It is the responsibility of field personnel to be familiar with the sampling procedures outlined within this POP, with specific sampling, quality assurance, and health and safety requirements outlined within this Sampling and Analysis Plan (SAP), the Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP). Field personnel are responsible for collecting samples, decontamination of equipment, and proper documentation in the field logbook, field forms, or electronic data collector such as the Trimble Yuma® or equivalent (if appropriate).

9.0 References

POP 102 – Chain of Custody Procedures.

POP 103 – Packaging and Shipment of Environmental Samples.

POP 105 – Decontamination of Field Equipment.

USGS. 2006. Chapter A4. Collection of Water Samples in National field manual for the collection of water-quality data collection of water samples TWRI Book 9.

Sediment Sampling – POP 202

1.0 Scope and Method Summary

This Project Operating Procedure (POP) describes the basic techniques and general considerations to be followed for the collection of surface sediment samples. For the purposes of this POP, sediment is defined as soil, sand, silt, clay, organic matter, or other materials that accumulate on the bottom of a water body (*U.S. EPA* 1998, 2001, and 2005). The specific details of actual sample collection are dependent upon local conditions as well as the purpose of the sampling.

Surface sediment sample collection generally involves collection of a representative sediment sample from, or near, a water body (e.g., stream, wetland, pond, or lake) into an appropriate container(s). Specific field conditions such as water depth, tidal status, and location are recorded. Field observations, such as presence and type of oil sheen and oil will also be recorded.

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

2.0 Health and Safety

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

3.0 Interferences

Potential interferences could result from cross-contamination between sample locations or entrainment of non-target material in the samples. Minimization of the cross-contamination will occur through the following:

- Approach of sample locations from downstream (tidal dependant),
- Collection of surface water samples prior to sediment samples at individual locations and as required,
- The use of clean, decontaminated or dedicated sampling tools at each location in the field and during sediment sample processing. Avoidance of material (e.g., re-suspended solids) that is not representative of the medium to be sampled.

4.0 Equipment and Supplies

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions or as specified in a work plan.

- Nautical equipment (anchors, lines, etc.),
- Universal Core® sampler (or similar), Lexan® core tubes (or similar), core tube catchers, core tube caps, aluminum extension rods (water depths less than 20 ft) or a gravity-driven slide hammer (deeper water),
- Petite Ponar® or Ekman dredge sampler,
- Hacksaw, cordless drill, drill bits, and power shears,
- Duct tape,
- Tape measure or survey stadia,

- Equipment decontamination supplies,
- Stainless steel bowls or Pyrex® containers and spoons, or similar disposable containers,
- Health and safety supplies (personal flotation devices, etc., as required by the HASP),
- Waterproof marker pens (Sharpie® or similar),
- Sample kit (i.e., bottles, labels, preservatives, custody records and tape, cooler, ice) or core storage kit (i.e., 5-gallon buckets, garbage bags, paper towels, cooler, ice),
- Sediment Sample Collection Record, field logbook, camera, and electronic data collector,
- Sample chain of custody forms,
- Sample packaging and shipping supplies,
- Field logbook, and
- Access to a boat when required for transportation.

5.0 Methods

5.1 Access to Sample Locations

Sample locations are presented in the project specific work plan. A boat may be needed to access sample locations. When boats are used for sampling, health and safety procedures as described in the HASP must be followed. Wading to locations may be considered, but is not the preferred method in the Anacostia River. If it is necessary to wade into the water body to obtain a sample, the sampler shall take care to minimize disturbance of bottom sediments and must enter the water body downstream of the sampling location.

5.2 Sample Location

Sample location will be identified with a Global Positioning System (GPS) unit. Pre-determined GPS identification numbers and coordinates will be used to determine correct sample placement whenever possible. Consideration must be given to maintain the sample location while sampling from boats; the use of anchors and other stabilizing devices may be required to help maintain a sample location. A measuring tape or measuring rod with a plate on the end will be used to determine water depth at the sample location in shallow water. If the depth of water dictates the use of an alternate measuring method, a sounding disc (secchi or similar) will be used.

5.3 Sediment Retrieval

All necessary sampling equipment and supplies listed in Section 6.0 and required personal protective equipment (PPE) should be loaded on the boat and the float plan communicated to the boat captain. After the sampling location has been reached, field personnel should ready the sampling device. Surface sediment samples will be collected using a Petite Ponar or equivalent sampling device.

5.4 Ponar or Ekman Dredge Sampling

After the sampling location has been reached, field personnel should ready the dredge sampling device by attaching a nylon rope, cable or pole to the top of the sampler. The sampler should then be placed in the “open” position. Slowly lower the sampler to just above the sediment surface and then drop the sampler quickly into the sediment to trigger the release mechanism, which should close the sampler. Raise the sampler to the water surface, inspect sample integrity, and carefully decant off surface water in the sampler through the screens. Open the sampler and transfer the contents to a stainless steel, Pyrex®, or disposable bowl. Samples for VOCs, simultaneously extracted metals (SEM), and acid volatile sulfide (AVS) will be collected prior to homogenization. If additional sample volume is needed, repeat collecting sediment in the manner described above.

5.5 Sample Handling and Preservation

Samples to be analyzed for VOCs, SEM, and AVS will be collected directly from the core or from the grab sample that has been deposited into a stainless steel bowl or similar prior to homogenization. Thoroughly homogenize (until visually uniform) the remaining sample interval after logging the core description. Fill the sample jars provided for the sampling location and appropriate analysis.

Once each sample container is filled, clean the rim and threads of the sample container by wiping with a paper towel.

Cap and label the container with (at a minimum) the sample identifier, sampling date and time, and sampler's initials. Additional information such as preservation information and analytical tests may also be added to the sample label as appropriate. Sample labeling will be conducted per the QAPP.

Place the sample containers into a cooler and maintain on ice. Complete sample chain of custody and other documentation per POP 102 Chain of Custody Procedures. Package the samples for shipment to the laboratory per POP 103 Packaging and Shipment of Environmental Samples.

5.6 Equipment Decontamination

All reusable equipment shall be decontaminated in accordance with *POP 105 Decontamination of Field Equipment.* All investigation derived waste generated from the sampling effort (gloves, disposable sampling equipment, decontamination water, etc.) shall be appropriately containerized and transported to the onsite collection area for appropriate disposal per *POP 106 Investigation Derived Waste Management*.

6.0 Data and Records Management

The data associated with sediment sample collection may be contained in the following:

- Sample labels,
- Chain of custody records and custody seal(s),
- Field logbook,
- Sample collection records,
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following POPs describe the data collection and record management procedures that should be followed as part of the sediment sample collection process:

- *POP 101 Field Records,*
- *POP 102 Chain of Custody Procedures,*
- *POP 103 Packaging and Shipment of Environmental Samples,*
- *POP 105 Decontamination of Field Equipment, and*
- *POP 106 Investigative Derived Waste Management.*

See the referenced POPs for additional details.

7.0 Quality Assurance and Quality Control

Quality Control (QC) samples collected during sediment sample collection may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

8.0 Personnel Qualifications

Sediment sample collection is a relatively involved procedure requiring formal training and a variety of equipment. It is recommended that initial sampling be supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration* (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous materials may be present.

It is the responsibility of the field personnel to be familiar with the sampling procedures outlined within this POP, with specific analytical sampling procedures, quality assurance, and health and safety requirements outlined within this *Sampling and Analysis Plan* (SAP), the *Quality Assurance Project Plan* (QAPP), the Health and Safety Plan (HASP) and work plans under which the sampling will be conducted. Field personnel are responsible for sample collection, decontamination of equipment, and proper documentation in the field logbook, field forms, or electronic data collector such as the Trimble Yuma® or equivalent (as appropriate).

9.0 References

ASTM-2488-09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

Code of Federal Regulations, Chapter 40 (Section 261.4(d)).

POP 101 – Field Records.

POP 102 – Chain of Custody Procedures.

POP 103 – Packaging and Shipment of Environmental Samples.

POP 105 – Decontamination of Field Equipment.

POP 106 – Investigation Derived Waste Management.

U.S. EPA. 1998. EPA's Contaminated Sediment Management Strategy. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 823/R-98/001.

U.S. EPA. 2001. Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. Office of Water EPA-823-B-01-002 October 2001.

U.S. EPA. 2005. Contaminated Sediment Remediation Guidance for Hazardous Waste Sites
USEPA, Office of Solid Waste and Emergency Response, EPA-540/R-05/012, 236 pp, 2005.

Subsurface Soil Sampling by Direct Push Methods – POP Number: 301

1.0 Scope and Method Summary

1.1 Purpose and Applicability

This POP describes the basic techniques and general considerations to be followed for the collection of subsurface soil samples using commercially available direct-push (Geoprobe Systems® for example) soil probing equipment. Subsurface soil samples may be obtained using this system for purposes of determining subsurface soil conditions and for obtaining soil samples for physical and/or chemical evaluation.

The purpose of this POP is to provide a description of a specific method or procedure to be used in the collection of subsurface soil samples using the direct push methods. Subsurface soil is defined as unconsolidated material which may consist of one or a mixture of the following materials: sand, gravel, silt, clay, peat (or other organic soils), and fill material. Subsurface soil sampling, conducted in accordance with this POP will promote consistency in sampling and provide a basis for sample representativeness.

This POP covers subsurface soil sampling using Geoprobe Systems® equipment (or equivalent); specifically, the Dual Tube Sampling Systems, the Macro-Core® Soil Sampler, and the Large Bore Sampler. Use of this sampling equipment requires use of a hydraulically-powered direct push percussion/probing machine or equivalent (Geoprobe Systems®).This technique is usually performed by subcontractors, although rental equipment is available for use by trained operators. For this project it is preferred that any direct-push sampling equipment be operated by a qualified and trained subcontractor.

Direct push sampling methods covered in this POP are applicable to unconsolidated soil/fill materials. Sampling depths are greatly dependent upon soil density as the hydraulically-powered probing unit has power limitations. Sample recovery is also somewhat dependent on grain size as very coarse gravel, cobbles, and boulders will occasionally cause premature refusal of the sample tooling. It is generally preferable to have some prior knowledge of site soil conditions if sampling activities are proposed where equipment limitations may become a factor.

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans as appropriate and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

1.2 General Principles

Soil sampling using the Geoprobe System® requires use of the hydraulically-powered percussion/probing machine and one of the Dual Tube Sampling Systems (DT22 or DT 325), the Macro-Core® Soil Sampler or the Large Bore Sampler soil sampling devices. The percussion/probing machine is typically mounted on a tracked or truck chassis. The percussion/probing machine, through its hydraulic operation, pushes and hammers the soil sampling equipment vertically into the ground. The soil sampler is then extracted from the ground to recover the sample.

The Dual Tube Sampling Systems (Figure 1) use two sets of probe rods to collect a continuous soil core; an outer rod and an inner rod containing a polyvinyl chloride (PVC) liner. The outer set of probe rods are directly driven by the percussion/probing machine and act as an outer casing preventing borehole collapse and providing a sealed borehole from which continuous soil samples can be collected. The smaller inner probe rods hold the sampler liner in place as the outer probe rods are driven into the ground. The inner rods are then removed from within the outer rods to retrieve the filled sample liner. Once the inner rods and attached sample liner are removed from the outer casing, the plastic liner containing the soil sample is removed from the tool. The liner is then cut, exposing the soil to be evaluated. This sampling tool is most often used for soil profiling and collection of larger volume soil samples.

Macro-Core® Sampler (Figure 2) consists of a 1.5-inch diameter open-ended steel sampling tool with liners made of clear plastic (Polyethylene Terephthalate Glycol (PETG) or PVC), stainless steel, or Teflon®. This sampler is designed for discrete interval sampling and is not affected significantly by borehole wall collapse. This sampler is similar to a piston sampler where a retractable drive (piston) point is withdrawn when the targeted sampling interval is achieved and the soil sample enters the sampler. Once the sampling tool is removed from the ground, the plastic liner containing the soil sample is removed from the tool. The liner is then cut, exposing the soil to be evaluated. This sampling tool is most often used for soil profiling and collection of larger volume soil samples.

The Large Bore Sampler (Figure 3) consists of a 22-inch long by a slightly over 1-inch diameter steel sampling tool and may be used for sampling to depths up to approximately 30 feet. Various liner types are available for use with this sampler, and include: plastic, brass, stainless steel, and Teflon®. The metal liners are available in segmented 6-inch lengths. This sampler is designed for discrete interval sampling and is not affected significantly by borehole wall collapse. This sampler is similar to a piston sampler where a retractable drive (piston) point is withdrawn when the targeted sampling interval is achieved and the soil sample enters the sampler. Once the sampler is removed from the ground, the inserted liner containing the soil sample is extracted from the sampler and the soil sample is then cut from or extracted from the liner. The segmented liner materials and discrete interval sampling capability gives this device greater suitability for collection of smaller volume soil samples.

2.0 Health and Safety Considerations

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, is addressed in the site specific Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

Boring completion may involve physical and/or chemical hazards associated with exposure to soil, water, sediment, or materials in contact with soil, water, or sediment. When Geoprobe® sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project HASP

3.0 Interferences

Potential interferences could result from cross-contamination between borehole locations. Minimization of the cross-contamination will occur through the use of clean sampling tools at each location, which will require decontamination of sampling equipment as per POP 105 – Decontamination of Field Equipment

4.0 Equipment and Supplies

In addition to those materials provided by the subcontractor, the following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Boring logs or electronic data collection (such as Trimble Yuma® or equivalent),
- Teaspoon, spatula, or equivalent,
- Analytical Sample kit (bottles, labels, preservatives, custody records, tape, cooler, and ice),
- Sample collection bowl or pan (if collecting a composite sample),
- Folding rule or tape measure,
- Munsell Soil Color Chart
- Equipment decontamination materials (as required by POP 105),
- Health and safety equipment (as required by the HASP), and
- Field project notebook and pen.

Sampling equipment which comes in direct contact with environmental samples during the sample collection process should be constructed of stainless-steel, Teflon®, or glass, unless specified otherwise in a work plan or Quality Assurance Project Plan (QAPP).

- Other materials that may be required:
- Liner cutter,
- Camera,
- Color chart,
- Gloves,
- Potable water supply,

- Plastic sheeting,
- Trash bags, and
- Paper towels
- Appropriate containers and materials to manage investigation derived waste (as specified in the Work Plan and as required by POP 106 – Investigative Derived Waste Management

5.0 Procedures

5.1 General Method Description

Direct Push soil sampling methods generally involve collection of soil samples by driving the sampling tool directly into the ground using the percussion/probing machine and without the aid of hollow-stem augers or other casing-installed drilling methods. The Dual Tube Sampling Systems, Macro-Core®, and Large Bore soil samplers consist of metal tubes of seamless construction which cannot be split apart like split-spoons. Liner/sleeve inserts are used to extract an intact soil core/sample from the sampling device.

These sampling devices operate by being directly pushed and/or hammered into the ground by the percussion/probing machine. The borehole is created as the sampling device is advanced downward. The Dual Tube Sampling Systems collect a continuous soil core utilizing an outer rod and an inner rod with a PVC (or other) liner. The outer set of probe rods are directly driven by the percussion/probing machine and act as an outer casing preventing bore hole collapse and providing a sealed borehole from which continuous soil samples can be collected. The smaller inner probe rods hold the sampler liner in place as the outer probe rods are driven into the ground. The inner rods are then removed from within the outer rods to retrieve the filled sample liner. Once the inner rods and attached sample liner are removed from the outer casing, the plastic liner containing the soil sample is removed from the tool. The liner is then cut, exposing the soil to be evaluated by the field staff.

The Macro-Core® Sampler can collect samples either continuously requiring an open borehole be maintained for efficient sample recovery or as a discrete sampler. The Large Bore Sampler contains a piston tip/drive point which allows for advancing the sampler to a designated depth for discrete interval sampling. The piston tip is retracted when the desired sampling interval is reached. When the soil sampling device is retrieved from the borehole, the drive head, cutting shoe and/or piston assembly is removed, and the liner insert with sample is removed from the sampling device. Field staff is then given access to the sample for whatever purpose is required.

Table 1 summarizes the construction characteristics and sampling attributes of each type of sampler. The appropriate type of sampler should be selected based on project-specific sampling requirements.

5.2 Equipment Decontamination

Non-dedicated sampling devices must be decontaminated prior to its initial use and following collection of each soil sample, especially if sampling for analytical testing purposes is conducted. If sampling for soil logging only is conducted, thorough sampler decontamination between samples may not be necessary although sufficient cleansing is necessary for the sampler to operate properly. Site-specific requirements for equipment decontamination are outlined in the POP 105 - Decontamination of Field Equipment.

5.3 Sampling Procedure – Dual Tube Sampling System

Sample Tooling

- Decontaminate the sampler parts (cutting shoe, inner and outer probe rods, and drive tips) before assembly.
- Assemble the outer probe rod with a cutting shoe. Tighten the cutting shoe with the shoe wrench or pipe wrench.
- Assemble the inner sampler by first placing a catch basket on one end of the PVC liner. Then place the drive head on the opposing end of the PVC liner. Insert the liner/drive head assembly into the outer probe rod such that the core catcher contacts the cutting shoe.
- Install the threadless drive cap onto the outer probe rod.
- Place entire assembly under the percussion/probing machine for driving.

Sampling

- Using the percussion/probing machine, drive the sampler completely into the ground until the drive head reaches the ground surface.
- Use the machine hydraulics to pull the inner rod(s) and sample liner from the outer probe rod.
- Repeat, adding another liner/drive head assembly and additional inner and outer probe rods to the drill string and proceed to collect continuous soil core until the targeted end-of-boring is reached.
- Once end-of-boring is attained, use the machine hydraulics to pull the outer probe rods before or during borehole abandonment.

Sample Recovery

- Use the machine hydraulics to pull the inner rod(s) and sample liner from the outer probe rod.
- Once the inner probe rods and liner/drive head assembly has been removed from the outer probe rods, the liner must be removed from the drive head.
- Disconnect the drive head from the liner which contains the soil sample. The recovered soil sample may now be viewed, logged, and extracted from the liner for analysis.

5.4 Sampling Procedure - Macro-Core® Sampler

Sample Tooling

- Decontaminate the sampler parts (cutting shoe, sample tube, liners (plastic liners are disposable and do not require decontamination)) before assembly.
- Assemble the sampler by first placing the catch basket in the end of the liner. Then place the basket and liner over the inside end of the cutting shoe, then inserting the liner/shoe assembly into the sample tube, and then finally threading the cutting shoe into the sample tube. Tighten the cutting shoe with the shoe wrench or pipe wrench.
- Thread the sampler onto the drive head.

Sampling

- Using the percussion/probing machine, drive the sampler completely into the ground until the drive head reaches the ground surface.
- Use the machine hydraulics to pull the sampler from the borehole.
- Repeat, advancing the sampler to the prior depth, adding a length of drilling rod.
- For sampling where subsurface conditions result in borehole collapse or sampling starts below ground surface, the sampler can be assembled as a discrete sampler with the addition of a piston rod, piston tip, and stop pin. Drive the sampler into the ground until the upper portion of the targeted sampling interval is achieved. Unthread and remove the stop-pin from the drive head using extension rods. This will activate the piston tip/rod.
- Drive the sampler through the targeted sampling interval to collect the sample. The piston tip/rod will retract as the sample enters the sample tube.
- Use the machine hydraulics to pull the sampler from the borehole.

Sample Recovery

- Once the sampler has been removed from the borehole, the sampler must be unthreaded from the drive head, the cutting shoe unthreaded from the sampler, and the liner/shoe assembly removed from the sample tube.
- Disconnect the cutting shoe from the liner which contains the soil sample. The recovered soil sample may now be viewed, logged, and extracted from the liner for analysis.

5.5 Sampling Procedure – Large Bore Sampler

Sampler Preparation

- Decontaminate the sampler parts (cutting shoe, piston rod/tip, sample tube, liners) before assembly.
- Assemble the sampler by first placing the catch basket and liner on the cutting shoe, then threading the liner/shoe assembly into the sample tube, then connecting the piston tip to the piston rod, and then finally

inserting the piston tip/rod assembly into the sample tube. Tighten the cutting shoe with the shoe wrench.
- Thread the sampler onto the drive head. Thread the stop-pin onto the drive head (stop-pin holds the piston tip/rod in place while driving the sampler to the desired sample interval).

Sampling

- Using the percussion/probing machine, drive the sampler into the ground until the upper portion of the targeted sampling interval is achieved.
- Unthread and remove the stop-pin from the drive head using extension rods. This will activate the piston tip/rod.
- Drive the sampler through the targeted sampling interval to collect the sample. The piston tip/rod will retract as the sample enters the sample tube.
- Use the machine hydraulics to pull the sampler from the ground.

Sample Recovery

- Once the sampler has been removed from the ground, the sampler must be unthreaded from the drive head, then the cutting shoe unthreaded from the sample tube, and the liner/shoe assembly removed from the sample tube.
- Disconnect the cutting shoe from the liner which contains the soil sample. The recovered soil sample may now be viewed, logged, and extracted from the liner for analysis.

5.6 Sample Containment

- The soil sample can be removed from the liner following viewing and/or logging. Non-segmented plastic or Teflon® liners should be cut in half with a retractable blade or other safe utensil to facilitate sample extraction or to isolate specific sample zones targeted for analysis. Segmented metal liners can be manually separated.
- The individual halves of the liners can then be screened with UV light if desired and fluorescence is noted on the boring log.
- Once the soil has been screened with UV light if conducted, the soil sample is inspected and a soil boring log can then be completed describing the soil type, color, visible oil, cohesiveness, moisture, plasticity, drive and recovery depths.
- The soil sample may then be extracted from the individual liner segments with a spoon or spatula. Then the sample should be placed directly into the required sample container.
- Once filled, the sample container should be properly capped, cleaned and labeled and recorded in the field book. Sample chain of custody and preservation procedures should then be initiated.
- If using disposable equipment, perform equipment decontamination following collection of the sample.

6.0 Data and Records Management

The data associated with subsurface soil sampling by Geoprobe® methods will be contained in the following:

- Boring logs (example shown as Figure 4 or equivalent),
  - Field screen results/observations and sample collection locations/intervals will be included on the Boring Log.
  - Driven depth and recovered depth will also be recorded.
- Sample collection records,
- Field logbook,
- Chain of custody records,
- Shipping labels,
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following POPs describe the data collection and record management procedures that should be followed as part of the sample collection process:

- *POP 101 Field Records,*

- *POP 102 Chain of Custody Procedures,*
- *POP 103 Packaging and Shipment of Environmental Samples, and*
- *POP 501 Photoionization Detector Measurement.*

See the referenced POPs for additional details.

7.0 Quality Assurance and Quality Control

Quality Control (QC) samples collected via subsurface soil sampling may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

8.0 Personnel Qualifications and Training

8.1 Field Staff

It is the responsibility of the field staff to conduct subsurface soil sampling in a manner which is consistent with this POP. Field staff will observe all activities pertaining to subsurface soil sampling to ensure that the POP is followed, and to record all pertinent data into a digital capture device, onto a boring log or into field logbook. It is also the responsibility of field staff to indicate the specific targeted sampling depth or sampling interval to the drilling subcontractor. Field staff will also collect representative environmental or stratigraphic characterization samples once the sampling device has been retrieved and opened. Additional sample collection responsibilities include labeling, handling, and storage of samples until further chain of custody procedures are implemented. Field personnel must be health and safety certified as specified by the Occupational Health and Safety Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials may be present.

8.2 Drilling Subcontractor

It is the responsibility of the drilling subcontractor to provide the necessary equipment for obtaining subsurface soil samples. This generally includes the truck- or all terrain vehicle-mounted percussion/probing machine and the Dual Tube System or one or more Macro-Core® and Large Bore samplers in good operating condition, appropriate liners, and other necessary equipment for borehole preparation and sampling. Equipment decontamination materials should also be provided by the subcontractor and decontamination should follow POP 105 – Decontamination of Field Equipment. Drilling personnel must be health and safety certified as specified by OSHA to work on sites where hazardous waste materials may be present.

9.0 References

Geoprobe Systems®, January 2011. Geoprobe® DT325 Dual Tube Sampling System, Standard Operating Procedure. Technical Bulletin No. MK3138.

Geoprobe Systems®, January 2011. Geoprobe® Macro-Core® MC5 1.25-inch Light-Weight Center Rod Soil Sampling System, Standard Operating Procedure. Technical Bulletin No. MK3139.

Geoprobe Systems®, January 2011. Geoprobe® DT22 Dual Tube Sampling System, Standard Operating Procedure. Technical Bulletin No. MK3140.

POP 101 – Field Records

POP 102 – Chain of Custody Procedures

POP 103 – Packaging and Shipment of Environmental Samples

POP 105 – Decontamination of Field Equipment

POP 106 – Investigative Derived Waste Management.

POP 503 – Photoionization Detector Measurement

Subsurface Soil Sampling by Hollow Stem Auger and Split-Spoon Sampler Methods– POP 302

1.0 Scope and Applicability

This Project Operating Procedure (POP) describes the basic techniques/procedures and general considerations to be followed for collecting subsurface soil samples using Hollow Stem Auger (HSA) and split-spoon sampler equipment. Subsurface soil samples may be obtained using this system for purposes of determining subsurface soil conditions and for obtaining soil samples for physical and/or chemical evaluation.

The sampling methods covered in this POP are applicable to unconsolidated soil/fill materials. Sample recovery is somewhat dependent on grain size as very coarse gravel, cobbles, and boulders will occasionally cause premature refusal of the sample tooling. It is generally preferable to have some prior knowledge of site soil conditions if sampling activities are proposed where equipment limitations may become a factor.

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

1.2 General Principles

Soil sampling using the split spoon sampler requires use of a 140 pound weight dropped 30 inches (ASTM Method D1586) if blow counts are required for geotechnical purposes or a hydraulically-powered percussion hammer to drive the sampler. The manual or hydraulic hammer drives the split spoon sampler vertically into the undisturbed soil ahead of the HSA. The soil sampler is then extracted from the ground to recover the sample.

The split-spoon sampler (Figure 1) consists of a 2-inch diameter by 2-foot long open-ended steel sampling tool that can be split in half by unscrewing the drive shoe. The sampler is attached to drilling rods and lowered through the HSAs where it is then driven ahead of the lead auger. Once the sampler is removed from the ground, the drive shoe is removed and the spoon is split in half, exposing the soil to be evaluated. This sampling tool is most often used for soil profiling and collection of soil samples.

2.0 Health and Safety Considerations

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, is addressed in the site specific Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

Boring completion may involve physical and/or chemical hazards associated with exposure to water, sediment, or materials in contact with either water or sediment. When sediment sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project HASP.

3.0 Interferences

Potential interferences could result from cross-contamination between borehole locations. Minimization of the cross-contamination will occur through the use of clean sampling tools at each location, which will require decontamination of sampling equipment as per POP 105 – Decontamination of Field Equipment.

4.0 Equipment and Materials

In addition to those materials provided by the subcontractor, the following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Boring Logs or electronic data collected (such as Trimble Yuma® or equivalent),
- Teaspoon, spatula, or equivalent,
- Sample kit (bottles, labels, custody records, tape, cooler, and ice),
- Sample collection pan (if collecting a composite sample),
- Folding rule or tape measure,
- Munsell Soil Color Charts

- Equipment decontamination materials (as required by the Quality Assurance Project Plan (QAPP),
- Health and safety equipment (as required by the HASP),
- Field project notebook, camera and pen,
- Work plan including site map and boring locations, and
- Ziploc® - style bags.

Sampling equipment which comes in direct contact with environmental samples during the sample collection process should be constructed of stainless steel, Teflon®, or glass, unless specified otherwise in the work plan or QAPP.

5.0 Procedures

5.1 General Method Descriptions

Split-spoon soil sampling methods generally involve collection of soil samples by driving the split-spoon sampler through the HSAs directly into the undisturbed soil ahead of the lead auger using the weight drop or percussion hammer.

When the split-spoon sampler is retrieved from the borehole, the drive shoe is removed, and the barrel is split in half to access the retrieved material. Field staff is then given access to the sample for visual examination/viewing and for whatever purpose is required.

5.2 Equipment Decontamination

Each split-spoon sampling device must be decontaminated prior to its initial use and following collection of each soil sample, especially if sampling for analytical testing purposes is conducted. If sampling for soil logging only is conducted, thorough sampler decontamination between samples may not be necessary although sufficient cleansing is necessary for the sampler to operate properly. Site-specific requirements for equipment decontamination are outlined in this Sampling and Analysis Plan (SAP). Equipment decontamination procedures are also outlined within POP 105 - Decontamination of Field Equipment.

5.3 Sampling Procedure – Split-Spoon Sampler

Sample Tooling

- Decontaminate the sampler parts (drive head, cutting shoe, and sample barrel) before assembly.
- Assemble the sampler by first placing the catch basket in the cutting shoe. Then assemble the two halves of the sample barrel and thread the cutting shoe and drive head onto the sample barrel. Tighten the drive head and cutting shoe with a pipe wrench.
- Thread the assembled sampler onto the drilling rod.

Sampling

- Lower the sampler to the bottom of the borehole by adding the appropriate amount of drilling rods.
- Drive the split-spoon sampler 24 inches (if a 24-inch sampler is used) and record the number of blow counts per 6 inches as appropriate.
- Use the drilling rig to pull the sampler from the borehole.

Sample Recovery

- Once the sampler has been removed from the borehole, the sampler must be unthreaded from the drilling rods and the drive head and cutting shoe unthreaded from the sample barrel.
- The sample barrel is split which contains the soil sample. The recovered soil sample may now be viewed, logged, and removed from the barrel for analysis.

5.4 Sample Containment

General

- Once the barrel has been split, the soil sample may be extracted from the sample barrel with a spoon or spatula. Then, the sample should be placed directly into the required sample container.
- Once filled, the sample container should be properly capped, cleaned, labeled and recorded in the field book. Sample chain of custody and preservation procedures should then be initiated.
- Perform equipment decontamination following collection of the sample.

6.0 Quality Assurance / Quality Control

Quality Control (QC) samples collected via hollow stem auger methods may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

7.0 Data and Records Management

The data associated with hollow stem auger split spoon sampling may be contained on the following:

- Sample labels,
- Chain of custody records and custody seal(s),
- Boring logs (example shown as Figure 2 or equivalent),
    - Field Screen results/observations and sample collection locations/intervals will be included on the Boring Log.
- Field logbook,
- Sample collection records, or
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required)

The following POPs describe the data collection and record management procedures that should be followed as part of the sample collection process:

- POP 101 – Field Records,
- POP 102 – Chain of Custody Procedures, and
- POP 103 – Packaging and Shipment of Environmental Samples.

See the referenced POPs for additional details.

8.0 Personnel Qualifications and Training

8.1 Field Staff

It is the responsibility of the field staff to conduct subsurface soil sampling in a manner which is consistent with this POP. Field staff will observe all activities pertaining to subsurface soil sampling to ensure that the POP is followed, and to record all pertinent data into a digital capture device, onto a boring log or into field logbook. It is also the responsibility of field staff to indicate the specific targeted sampling depth or sampling interval to the drilling subcontractor. Field staff will also collect representative environmental or lithologic characterization samples once the sampling device has been retrieved and opened. Additional sample collection responsibilities include labeling, handling, and storage of samples until further chain of custody procedures are implemented.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials may be present.

8.2 Drilling Subcontractor

It is the responsibility of the drilling subcontractor to provide the necessary tooling for obtaining subsurface soil samples. This generally includes the truck or All Terrain Vehicle-mounted HSA drilling rig and one or more split-spoon samplers in good operating condition, and other necessary equipment for borehole preparation and sampling. Equipment decontamination materials should also be provided by the subcontractor and should meet project specifications.

Drilling personnel must be health and safety certified as specified by OSHA to work on sites where hazardous waste materials may be present.

9.0 References

- ASTM Method D 1586-08a, Standard Test Method for Standard Penetration Test (STP0 and Split-Barrel Sampling of Soil, ASTM Committee on Standards, Philadelphia, PA.
- POP 101 – Field Records
- POP 102 – Chain of Custody Procedures
- POP 103 – Packaging and Shipment of Environmental Samples
- POP 105 – Decontamination of Field Equipment

Figure 1 – Split-Spoon Sampler

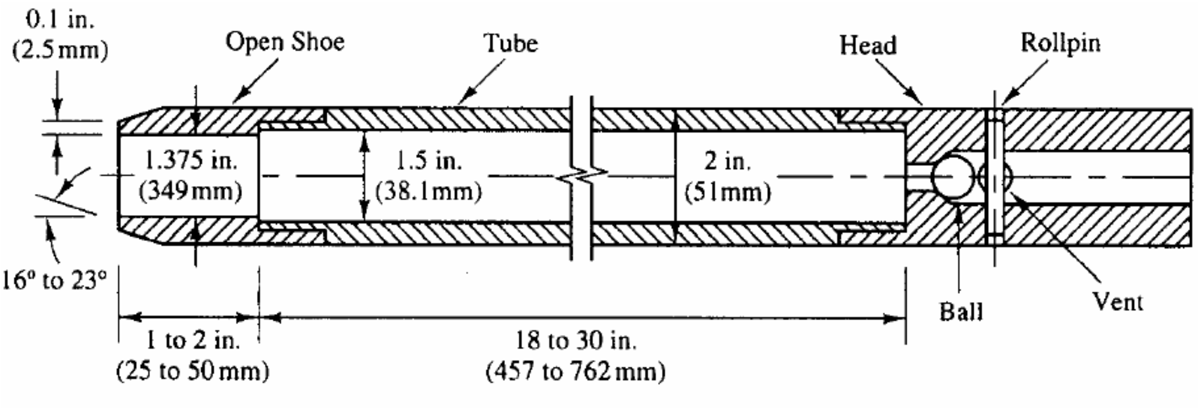
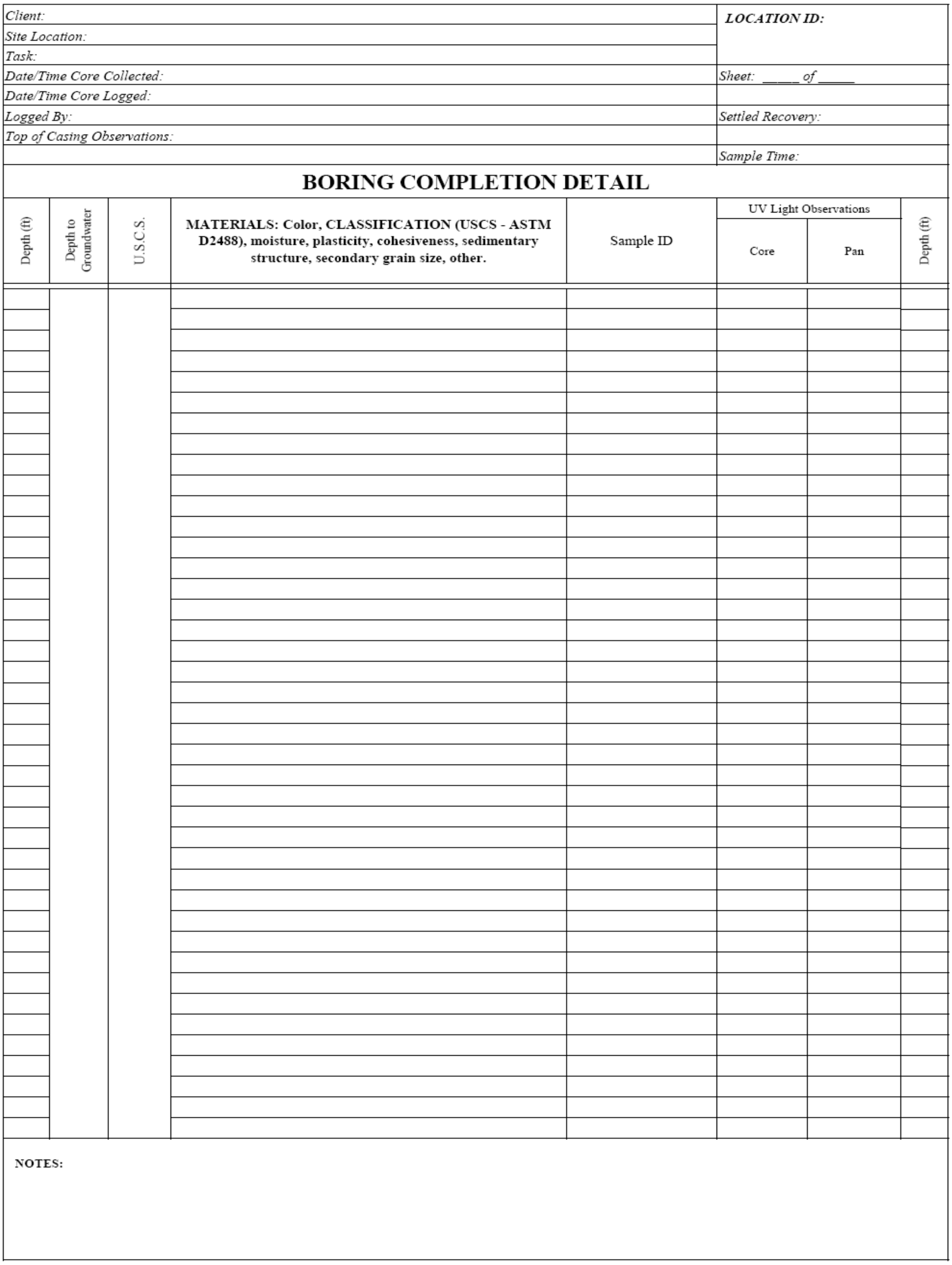


Figure 2 Typical Boring Log



Client:
Site Location:
Task:
Date/Time Core Collected:
Date/Time Core Logged:
Logged By:
Top of Casing Observations:

LOCATION ID:
Sheet: _____ of _____
Settled Recovery:
Sample Time:

BORING COMPLETION DETAIL

Depth (ft)	Depth to Groundwater	U.S.C.S.	**MATERIALS: Color, CLASSIFICATION (USCS - ASTM D2488), moisture, plasticity, cohesiveness, sedimentary structure, secondary grain size, other.**	Sample ID	UV Light Observations		Depth (ft)
					Core	Pan	

NOTES:

Surface Soil Sampling – POP Number: 304

1.0 Scope and Method Summary

1.1 Purpose and Applicability

This POP describes the basic techniques and general considerations to be followed for obtaining surface soil samples for physical and/or chemical analysis. For purposes of this POP, surface soil (including shallow subsurface soil) is loosely defined as soil that is present within one foot of the ground surface and can be sampled with the use of readily available and easy-to-operate sampling equipment.

The purpose of this POP is to provide a specific method and/or procedure to be used in the collection of surface soil samples which, if followed properly, will promote consistency in sampling and provide a basis for sample representativeness.

This POP is generally applicable to surface soils which are unconsolidated and are of low to moderate density. Higher density or compacted soils may require use of drill rigs or other powered equipment to effectively obtain representative samples.

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

1.2 General Principles

Surface soil sampling generally involves use of hand-operated equipment to obtain representative soil samples from the ground surface and to shallow depths below the ground surface. If soil conditions are appropriate, surface soil sampling, following the procedures described in this POP, can provide representative soil samples in an efficient manner.

2.0 Health and Safety Considerations

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, is addressed in the site specific Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

Surface soil sampling may involve physical and/or chemical hazards associated with exposure to water, sediment, or materials in contact with either water or sediment. When sediment sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project HASP.

3.0 Interferences

Potential interferences could result from cross-contamination between samples or sample locations. Additional interference could result from using contaminated equipment, disturbance of the matrix in compaction of the sample or inadequate homogenization of the sample. Minimization of the cross-contamination will occur through the use of clean sampling tools at each location, which will require decontamination of sampling equipment as per POP 105 – Decontamination of Field Equipment. Improper sample collection will be minimized by careful adherence to this POP.

4.0 Equipment and Supplies

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Survey equipment or global positioning system (GPS) to locate sampling points,
- Work Plan including site map and sample parameters,
- Spoons or scoops, trowel, spatula, shovel, or hand or bucket auger,

- Field forms or electronic data collected (such as Trimble Yuma® or equivalent),
- Sample kit (bottles, preservatives, labels, custody records, tape, cooler, and ice),
- Ziploc®-style bags,
- Plastic sheeting or tarp,
- Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan,
- Camera, logbook, and pen,
- Folding rule or tape measure,
- Munsell Soil Color Charts
- Equipment decontamination materials (as required by Quality Assurance Project Plan (QAPP), and
- Health and safety equipment (as required by the HASP).

Sampling equipment which comes in direct contact with environmental samples during the sample collection process should be disposable or constructed of stainless steel, Teflon®, or glass, unless specified otherwise in the work plan or QAPP. Chrome plated equipment typically found in hardware stores should not be used for sampling equipment.

5.0 Procedures

5.1 General Method Description

Site-specific soil characteristics such as soil density and moisture will generally dictate the preferred type of sampling equipment for use at a particular site. Similarly, other project-specific requirements such as sampling depth and requested type of analysis such as physical testing (e.g., grain-size distribution) and/or chemical analysis will dictate the use of a preferred type of sampling equipment. Analytical testing requirements will indicate sample volume requirements that also will influence the selection of the appropriate type of sampling tool.

Sample volume and sampling depth requirements are defined in the Work Plan. For samples requiring a large volume of soil, multiple holes and soil compositing may be necessary.

5.2 Equipment Decontamination

Unless disposable or one time use sampling equipment is used, each piece of equipment needs to be decontaminated prior to its initial use and following collection of each individual soil sample. Site-specific requirements for equipment decontamination are outlined within POP 105 - Decontamination of Field Equipment.

5.3 Collection of Samples for Volatile Organic Compound Analysis

Collection of surface soil samples for VOC analysis is different than collection of soil samples for other routine physical or chemical testing primarily because of the concern for potential loss of volatiles during the normal sample collection procedure. To limit the potential for loss of volatiles, the soil sample must be obtained as quickly and as directly as possible. This generally means that if a VOC sample is to be collected as part of a multiple analyte sample, the VOC sample portion should be obtained first. The VOC sample should also be obtained from a discrete portion of the entire collected sample and not from a sample which has been composited or homogenized from the entire sample interval. In general, it is best to collect the VOC sample by transferring the sample directly from the sampling tool into the sample bottles. Intermediate sample containers such as collection pans should not be used during collection of VOC samples.

5.4 Standard Procedures

Surface Preparation

At some sampling locations, the ground surface may require preparation in advance of sampling. Surface preparation can include the following: removal of concrete or asphalt; removal of surface debris which blocks access to the actual soil surface; and loosening of dense surface soils such as those encountered in heavy traffic areas, or frozen soils. If sampling equipment is used for both removal of surface debris and for collection of the soil sample, the equipment should be decontaminated prior to sample collection to reduce the potential for sample interferences between the surface debris and the underlying soil.

Spoon, Scoop, and Trowel Sampling Procedure

Shovels, spoons, scoops, and trowels are of similarly designed construction and can therefore be operated in accordance with the following procedure.

- Select the sampling location and prepare the surface by removal of surface debris if present. Surface preparation should be completed using other appropriately decontaminated sampling equipment.

- Decontaminate the shovel, spoon, scoop, or trowel in accordance with POP 105 - Decontamination of Field Equipment prior to use.
- The soil sample should be obtained by inserting the sampling tool into the ground and rotating the tool so that a representative "column" of soil is removed from the ground.
- The immediate objective is to collect the VOC sample fraction first if this is required. If a specific depth below the ground surface has been targeted for the VOC sample, the overlying soils should be removed and discarded or placed into a soil collection pan as part of the remaining composite sample.
- Regardless of whether or not a VOC sample is required, one or more cores or scoops of soil may be needed until the desired sampling depth is achieved. Removal of a representative column of soil in cohesionless soils may be difficult to achieve. If more soil is needed to meet sample volume requirements, additional columns of soil may be collected from an immediately adjacent location.
- Except for VOC samples, as each portion of the sample is removed from the ground, it should be placed into an intermediate sample container (collection pan or bowl) until the entire sample interval of soil is removed and all vertical intervals are adequately represented.
- Once the sample interval has been collected, the soil sample should be thoroughly homogenized within the collection pan prior to bottling. Sample homogenizing is accomplished by manually mixing the entire soil sample in the collection pan until a uniform mixture is achieved.
- The appropriate sample containers should be filled with soil from the collection pan.
- Once each sample container is filled, the rim and threads of the sample container will be cleaned of soil, then capped and labeled. Do not submerge the sample containers in water to clean them. Once labeled the sample containers should be placed into a cooler for protection. Sample chain of custody and other documentation requirements should be completed at this time or in the field office.
- The sampling tool and other sampling equipment (if not disposable) should be decontaminated prior to reuse. All investigation derived waste should be properly contained before leaving the area.
- The sample hole should be backfilled to eliminate any surface hazard.

6.0 Data and Records Management

The data associated with subsurface soil sampling by Geoprobe® methods will be contained in the following:

- Sample collection records,
- Field logbook,
- Chain of custody records,
- Shipping labels,
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following POPs describe the data collection and record management procedures that should be followed as part of the sample collection process:

- *POP 101 Field Records,*
- *POP 102 Chain of Custody Procedures,*
- *POP 103 Packaging and Shipment of Environmental Samples, and*

See the referenced POPs for additional details.

7.0 Quality Assurance and Quality Control

Quality Control (QC) samples collected via subsurface soil sampling may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

8.0 Personnel Qualifications and Training

It is the responsibility of the field staff to conduct surface soil sampling in a manner which is consistent with this POP. Field staff will observe all activities pertaining to surface soil sampling to ensure that the POP is followed, and to record all pertinent data into a digital capture device, onto a boring log or into a field logbook. Additional sample collection responsibilities include labeling, handling, and storage of samples until further chain of custody procedures are implemented.

9.0 References

POP 101 – Field Records

POP 102 – Chain of Custody Procedures

POP 103 – Packaging and Shipment of Environmental Samples

POP 105 – Decontamination of Field Equipment

Soil Sampling via Hand Auger – POP 305

1.0 Scope and Applicability

This Project Operating Procedure (POP) describes the basic techniques and general considerations to be followed for the collection of subsurface soil samples for physical and/or chemical analysis. For purposes of this POP, subsurface soil is loosely defined as soil that is located greater than one foot from the ground surface and can be sampled with the use of readily available and easy-to-operate sampling equipment. This POP is generally applicable to subsurface soils which are unconsolidated and are of low to moderate density. Higher density or compacted soils may require use of drill rigs or other powered equipment to effectively obtain representative samples.

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

1.2 General Principles

Subsurface soil sampling generally involves the use of hand-operated equipment to obtain representative soil samples from shallow depths below the ground surface. If soil conditions are appropriate, subsurface soil sampling, following the procedures described in this POP, can provide representative soil samples in an efficient manner.

2.0 Health and Safety Considerations

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, are addressed in the site specific Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

3.0 Interferences

Potential interferences could result from cross-contamination between samples or sample locations. Additional interference could result from using contaminated equipment, disturbance of the matrix in compaction of the sample or inadequate homogenization of the sample. Minimization of the cross-contamination will occur through the use of clean sampling tools at each location, which will require decontamination of sampling equipment as per POP 105 – Decontamination of Field Equipment. Improper sample collection will be minimized by careful adherence to this POP.

4.0 Equipment and Materials

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Survey equipment or global positioning system to locate sampling points;
- Work plan including site map and sample parameters;
- Spoons or scoops, trowel, spatula, shovel, and hand or bucket auger;
- Field forms or electronic data collected (such as Trimble Yuma® or equivalent);
- Sample kit (bottles, labels, custody records, tape, cooler, and ice);
- Ziploc®-style bags;
- Plastic sheeting or tarp;
- Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan;
- Camera, logbook, and pen;
- Folding rule or tape measure;
- Munsell Soil Color Charts
- Equipment decontamination materials (as required by the Quality Assurance Project Plan (QAPP); and

- Health and safety equipment as required by the HASP.

Sampling equipment which comes in direct contact with environmental samples during the sample collection process should be disposable or constructed of stainless steel, Teflon®, or glass, unless specified otherwise in a work plan or the QAPP. Chrome plated equipment typically found in hardware stores should not be used for sampling equipment.

5.0 Procedures

5.1 General Method Descriptions

Site-specific soil characteristics such as soil density and moisture will generally dictate the preferred type of sampling equipment for use at a particular site. Similarly, other project-specific requirements such as sampling depth and requested type of analysis such as physical testing (e.g., grain-size distribution) and/or chemical analysis will dictate the use of a preferred type of sampling equipment. Analytical testing requirements will indicate sample volume requirements that also will influence the selection of the appropriate type of sampling tool.

Sample volume and sampling depth requirements are defined in the work plan. For samples requiring a large volume of soil, multiple holes and soil compositing may be necessary. Collection of the requisite volume of soil to meet sample volume requirements without underestimating the sample volume is the overall objective and is a technique which improves with experience.

5.2 Equipment Decontamination

Unless disposable or one time use sampling equipment is used, each piece of equipment needs to be decontaminated prior to its initial use and following collection of each individual soil sample. Site-specific requirements for equipment decontamination are outlined within POP 105 - Decontamination of Field Equipment.

5.3 Collection of Samples for Volatile Organic Compound (VOC) Analysis

Collection of subsurface soil samples for VOC analysis is different than collection of soil samples for other routine physical or chemical testing primarily because of the concern for potential loss of volatiles during the normal sample collection procedure. To limit the potential for loss of volatiles, the soil sample must be obtained as quickly and as directly as possible. This generally means that if a VOC sample is to be collected as part of a multiple analyte sample, the VOC sample portion should be obtained first. The VOC sample should also be obtained from a discrete portion of the entire collected sample and not from a sample which has been composited or homogenized from the entire sample interval. In general, it is best to collect the VOC sample by transferring the sample directly from the sampling tool into the sample bottles. Intermediate sample containers such as collection pans should not be used during collection of VOC samples.

5.4 Standard Procedures

Surface Preparation

- At some sampling locations, the ground surface may require preparation in advance of sampling. Surface preparation can include removal of surface debris which blocks access to the actual soil surface or loosening of dense surface soils such as those encountered in heavy traffic areas, or frozen soils. If sampling equipment is used for both removal of surface debris and for collection of the soil sample, the equipment should be decontaminated prior to sample collection to reduce the potential for sample interferences between the surface debris and the underlying soil.

Auger Sampling

- A bucket auger may be used to collect soil samples from depths ranging from one to approximately five feet. In some instances, soil samples may be collected from greater depths, but often with considerable difficulty. Bucket augers allow for discrete depth interval sampling as the soil is retained within the hollow tube of the auger when it is extracted from the ground. It should be noted that if depth-discrete sampling is the objective, more than one auger may be necessary, with one auger used to provide access to the required sampling depth and the other (clean) auger used for sample collection.

- Select the sampling location and prepare the surface by removal of surface debris, if present.
- Decontaminate re-usable equipment in accordance with POP 105 - Decontamination of Equipment.
- When using the bucket auger, the auger should be pushed downward and rotated until the bucket becomes filled with soil. Usually a 6 - to 12-inch core of soil is obtained each time the auger is inserted. Once filled, the auger should be removed from the ground and emptied on a sterile surface (plastic sheeting) and transfer to a plastic bag if sampling is required. If a VOC sample is required, the sample should be taken directly from the auger using a teaspoon or spatula and/or directly filling the sample container from the auger. The augering process should be repeated until the desired sample interval has been augered.
- If the desired sample interval is located at a specific depth below the ground surface, the unwanted interval can be removed with one auger and the soil discarded. Sample collection can then proceed in normal fashion using a clean auger or following decontamination of the original auger.
- Except for VOC sample fractions, the remainder of the soil sample should be thoroughly homogenized in the soil collection pan prior to the collection of the sample.
- The appropriate sample containers should be filled with soil from the collection pan. Once each sample container is filled, the rim and threads of the sample container will be cleaned of gross soil, then capped and labeled. Do not submerge the sample containers in water to clean them. Once labeled the sample containers should be placed into a cooler for protection. Sample chain of custody and other documentation requirements should be completed at this time.
- All used sampling equipment should be decontaminated prior to reuse and investigation-derived waste should be properly contained before leaving the area.
- The sample hole should be backfilled with clean soil and/or a combination of clean soil and bentonite chips to eliminate any surface hazard.

6.0 Quality Assurance / Quality Control

Quality Control (QC) samples collected via hand auger may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

7.0 Data and Records Management

The data associated with soil sampling via hang auger will be contained in the following:

- Sample labels,
- Chain of custody records and custody seal(s),
- Boring logs,
- Field logbook,
- Sample collection records,
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following POPs describe the data collection and record management procedures that should be followed as part of the sample collection process:

POP 101	Field Records,
POP 102	Chain of Custody Procedures, and
POP 103	Packaging and Shipment of Environmental Samples.

See the referenced POPs for additional details.

8.0 Personnel Qualifications and Training

It is the responsibility of the field staff to conduct subsurface soil sampling in a manner which is consistent with this POP.

Field staff will observe all activities pertaining to subsurface soil sampling to ensure that the POP is followed, and to record all pertinent data into a digital capture device, onto a boring log or into field logbook. Additional sample collection responsibilities include labeling, handling, and storage of samples until chain of custody procedures are implemented.

9.0 References

- POP EN 101 – Field Records
- POP 102 – Chain of Custody Procedures
- POP 103 – Packaging and Shipment of Environmental Samples
- POP 105 – Decontamination of Field Equipment

Monitoring Well Construction and Installation, POP Number: 401

1.0 Scope and Method Summary

This Project Operating Procedure (POP) describes the basic techniques and general considerations to be followed when installing groundwater monitoring wells. Monitoring wells may be installed to monitor the depth to groundwater, to measure aquifer properties, and to obtain samples of groundwater for chemical analysis.

Monitoring well construction and installation generally involves drilling a borehole using conventional drilling equipment, installing commercially available well construction and filter/sealing materials, and development of the well prior to sampling. This POP covers well construction and installation methods only. Well development methods are covered under POP No. 402 - Monitoring Well Development.

This POP is applicable to installation of single monitoring wells within a borehole.

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

2.0 Health and Safety Considerations

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

3.0 Interferences

Potential interferences could result from cross-contamination between borehole locations. Minimization of the cross-contamination will occur through the use of clean sampling tools at each location, which will require decontamination of sampling equipment as per POP 105 – Decontamination of Field Equipment.

Other potential interferences may be due to well materials or interactions between well materials and the formation. The process of installing a well necessarily disturbs the geologic formation. Wells will be developed appropriately as described in POP 402 – Monitoring Well Development. The wells will be allowed to stabilize a minimum of twenty-four hours after development before a well is sampled to allow stabilization of both well construction and geological material.

Cross-contamination may also result when surface water runoff or other materials enter the well from the ground surface. To minimize this, wells will be installed with stick-up casings where possible. Where such wells may be at risk of damage from traffic (i.e., near roadways), bumpers may be placed around the well to prevent them from being hit. Where flush-mount well completions are necessary, such as at locations preferred by property owners, appropriate steps will be taken to reduce the potential for infiltration into the well as described in the following sections.

4.0 Equipment and Supplies

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

4.1 Well Construction Materials

Well construction materials are usually provided by the drilling subcontractor. The wells will consist of commercially available flush-threaded, wire wrap (if requested) well screen and riser pipe constructed of poly vinyl chloride (PVC), or stainless steel. Typically these will be with a minimum 2 or 4-inch inside diameter, however, alternate diameter wells may be used.

4.2 Well Completion Materials

Well completion materials include silica sand, bentonite, cement, protective casings, J-plugs, and locks. Completion materials are generally provided by the drilling subcontractor.

4.3 Other Required Materials

- Monitoring Well Construction Diagrams and field logbook and pen,
- Potable water supply,
- Plastic sheeting,
- Trash bags,
- Paper towels,
- Water level meter,
- Self-adhesive well labels,
- Waterproof marker or paint (to label wells),
- Equipment decontamination supplies,
- Health and safety supplies (as required by the HASP),
- Appropriate containers and materials to manage investigation derived waste (IDW) (as specified in POP 106 Investigative Derived Waste), including non-hazardous waste labels.

5.0 Procedures

5.1 General Preparation

Borehole Preparation

Standard drilling methods including, but not limited to, direct push, hollow stem auger and sonic drilling, should be used by the drilling subcontractor under the supervision of field personnel to achieve the desired drilling/well installation target depths. A hand auger may be used at shallow well locations not accessible by a drilling rig.

The typical diameter of the borehole (inside the auger) will be a minimum of 2-inches greater than the outside diameter of the well screen/ riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs, bentonite seals, and grout seals. However, in limited situations, due to the potential need for direct drive monitoring wells, a smaller diameter annulus may limit the diameter of the filter pack. In some situations, for example pre-pack or “stab” wells, little to no filter pack may be used.

If the borehole is installed using hand auger techniques, a bucket auger will be used to install the boring to the proposed depth. If the soil conditions do not allow the boring to remain open, a 4- to 6-inch diameter casing may be driven to depth to keep soil from collapsing into the boring.

Well Material Decontamination

New well materials (well screen and riser pipe) generally arrive at the site boxed and sealed within plastic bags, so decontamination prior to use is not anticipated. Well materials should be inspected by the field personnel upon delivery to check cleanliness. If the well materials appear dirty, then they should not be used and new materials should be requested.

5.2 Well Construction Procedure

Depth Measurement

Once the target drilling depth has been reached, the drilling subcontractor will measure the total open depth of the borehole with a weighted tape measure or equivalent. Adjustments of borehole depth can be made at this time by drilling further or installing a small amount of sand filter material to achieve the desired depth. The water table depth may also be checked with a water level indicator.

Well Construction

The well screen and riser pipe generally are assembled by hand as they are lowered into the borehole through the hollow-stem augers. Before the well screen is inserted into the borehole, an end cap will be placed on the screen and the full length of the slotted portion of the well screen as well as the un-slotted portion of the bottom of the screen and end cap should be measured with a measuring tape. These measurements should be recorded on the well construction diagram.

After the above measurements have been taken, the drilling subcontractor may begin assembling the well. As the assembled well is lowered, care should be taken to ensure that it is centered in the hole. The well should be temporarily capped or covered before filter sand and other annular materials are installed. The well should be set at the base of the borehole or set on a sand pack if the borehole is back filled to the target screen depth, and this should be confirmed by observation or measurement at the time of installation.

Filter Sand Installation

A natural collapse sand pack around the well screen may be used at select locations to aid in the migration of free phase oil through pre-wetted soil. Filter sand will be added to the annular space that does not collapse as described below. The drilling subcontractor should fill the annular space surrounding the screened section of the monitoring well to at least one foot above the top of the slotted portion of the screen, or as dictated by field conditions, with appropriately graded, clean sand or fine gravel. In general, the filter pack should not extend more than three feet above the top of the slotted portion of the screen to limit the thickness of the monitoring zone. If coarse filter materials are used, an additional 1-foot thick layer of fine sand should be placed immediately above the filter pack to prevent the infiltration of sealing components (bentonite or grout) into the filter pack. As the filter pack is placed, a weighted tape should be lowered into the annular space to verify the depth to the top of the layer. Depending upon depth, some time may be required for these materials to settle. If necessary, to eliminate possible bridging or creation of voids, placement of the sand pack may require the use of a tremie pipe. Tremie pipe sand pack installations are generally suggested for deep water table wells and for wells that are screened some distance beneath the water table. The augers/casing should be gradually removed from around the well as the sand pack is being installed.

Bentonite Seal Installation

A minimum 2-foot thick layer of bentonite pellets or slurry seal will be installed by the drilling subcontractor immediately above the well screen filter pack in all monitoring wells. The purpose of the seal is to provide a barrier to vertical flow of water in the annular space between the borehole and the well casing. Bentonite is used because it swells significantly upon contact with water. Pellets or chips generally can be installed in shallow boreholes by pouring them very slowly from the surface. If they are poured too quickly, they may bridge at some shallow, undesired depth. As an option, powdered bentonite may be mixed with water into a thick slurry and a tremie pipe can be used to inject the material at the desired depth. The bentonite materials will be hydrated by adding water to them after they have been placed in the borehole.

Under normal circumstances, extreme care will be undertaken to avoid advancement of boreholes through confining layers. If it becomes necessary to do so, however, an outer casing will be set in the confining layer and grouted in place. The integrity of the casing seal will be verified by evacuating the casing of all accumulated water and monitoring the casing interior for 24 hours to ensure no formation water enters the casing before proceeding with borehole advancement. If the confining layer is present above the well screen, an attempt will be made to set the bentonite seal at the same depth as the confining layer if possible to isolate the permeable zone from other portions of the borehole.

Annular Grout Seal Installation

The remainder of the annular space between the bentonite seal and the bottom of the concrete pad (typically 0 to 3 ft below grade), will be filled with grout or continued to be filled with bentonite chips or pellets. The grout seal should consist of a bentonite/cement mix with a ratio of bentonite to cement of between 1:5 and 1:20. The grout ratio should be chosen by the drilling subcontractor based on site conditions with a higher percentage of bentonite generally used for formations with higher porosity. The grout material will be mixed with water and placed into the borehole using a tremie pipe.

Bentonite chips or pellets utilized to backfill the annular space should be placed in the borehole and hydrated utilizing potable water taking care not to allow bridging of the material. Drill cuttings will not be used as backfill material.

Protective Casing/Concrete Pad Installation

The drilling subcontractor will cut the top of the well to the desired height and install a locking cap. Well casings are usually cut to be a certain height above ground surface (typically 2.5 to 3 feet) or are cut to be slightly below the ground surface, depending on the well location.

The drilling subcontractor will install a protective casing for wells finished above grade. A cement apron, flush to grade, will be installed to hold the protective casing (i.e., road boxes or stand up casing) in place. The surface of the concrete pad will be sloped so that drainage occurs away from the well. Flush-mount protective casings should be completed such that they are slightly mounded above the surrounding surface to prevent surface water from running over or ponding on top of the casing.

In areas subject to snowfall, flush-mount casings may have to be installed so that they are entirely flush with the ground surface as they may be damaged by snow plows.

Above-ground protective casings should also be vented or should have non-air tight caps. Road box installations should not be vented. Installation of additional guard pipes or bollard posts may be necessary around above-ground well completions in traffic areas. All new monitoring wells will include a locking well cap with locks that are keyed alike.

Well Numbering

The field personnel will number each well casing with an indelible marker or paint to identify the well. This is particularly important with nested or paired wells to distinguish between shallow and deep wells. The well should be labeled on both the outside of the protective casing and inside beneath the protective casing lid. Well identification numbers will be as specified in the work plan and this SAP.

Measuring Point Identification

Field personnel will mark the measuring point (normally on the north side of the well casing) from which water level measurements will be made at the upper edge of the well casing. PVC wells can be notched with a pocket knife or saw, or can be marked with a waterproof marker on the outside of the well casing with an arrow pointing to the measuring point location or a mark on the rim of the casing. The measuring point is the point that will require surveying during the well elevation survey task.

Well Measurements

Upon completion, the following well measurements should be taken by field personnel and recorded on the Monitoring Well Construction Diagram (form or digital capture):

- Depth to static water level if water level has stabilized (refer to POP 403 – Water Level Measurement in a Monitoring Well),
- Total length of well measured from top-of-well casing (refer to POP 403 – Water Level Measurement in a Monitoring Well),
- Height of well casing above/below ground surface,
- Height of protective casing above/below ground surface,
- Depth of bottom of protective casing below ground surface (may be estimated).

Well screen filter pack, bentonite seal, and annular seal thicknesses and depths should also be recorded on the Monitoring Well Construction Diagram.

Disposal of Drilling Wastes

Drill cuttings and other disposable materials must be properly contained, labeled, and disposed of. Site-specific requirements for collection and removal of these waste materials are outlined in the POP or work plan. Containment of these materials should be performed by the drilling subcontractor.

Well Development

At some point after installation of a well and prior to use of the well for water level measurements or collection of water quality samples, development of the well shall be undertaken in accordance with POP 402 - Monitoring Well Development.

Well Elevation Survey

At the completion of the well installation program, all monitoring wells will be surveyed to provide, at a minimum, the location (x and y coordinates), top-of-casing measuring point elevation for water level monitoring purposes, and ground surface elevation. All top-of-casing measurements will be made to within 0.01-feet and horizontal measurements to within 0.1 foot.

6.0 Data and Records Management

All field information will be recorded in the field logbook or on a field collection form or in an electronic data collector (such as a Trimble Yuma® or equivalent) by field personnel. In addition, a field project logbook will be maintained detailing any problems or unusual conditions that may have occurred during the well drilling and installation process. The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

7.0 Quality Assurance and Quality Control

Field personnel should follow specific quality assurance guidelines as outlined in the QAPP and/or this SAP. Certain quality control measures, as noted below, should be taken to ensure proper well completion.

- The borehole will be checked for total open depth, and extended by further drilling or shortened by backfilling, if necessary, before any well construction materials are placed.
- The water level will be checked during well installation to ensure that the positions of well screen, sand pack, and seal relative to water level conform to project requirements.
- The depth to the top of each layer of packing (i.e., sand, bentonite, and grout) will be verified and adjusted if necessary to conform to project requirements before the next layer is placed.
- If water or other drilling fluids (for example, to control heaving sands) have been introduced into the boring during drilling or well installation, samples of these fluids may be required for analysis of chemical constituents of interest.
- The volume of water or other drilling fluids introduced into the boring will be accurately measured by using a flow gauge or documenting the volume of water in the storage tank before and after the introduction of the fluids. These measurements will be recorded in the field log for future reference.

8.0 Personnel Qualifications and Training

Well construction and installation requires a moderate degree of training and experience as numerous drilling situations may occur that will require field decisions to be made. It is recommended that inexperienced personnel be supervised for several well installations before working on their own. Geologists or personnel with applicable experience should supervise well installation.

It is the responsibility of the field personnel to be familiar with the procedures outlined in this POP and to directly oversee the construction and installation of the monitoring well by the drilling subcontractor to ensure that well installation specifications are completed in accordance with this POP. It is also the responsibility of the field personnel to be familiar with the procedures outlined within this SAP, the Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP). Field personnel are also responsible to make sure that proper decontamination procedures are followed, as well as proper documentation in the field logbook or field forms or field computer is completed.

It will be the responsibility of the drilling subcontractor to provide a trained operator and the necessary equipment for well construction and installation. Well construction materials should be consistent with project requirements. Monitoring well construction personnel who work on sites where hazardous waste materials may be present will be health and safety certified as specified by OSHA (29 CFR 1910.120(e)(3)(i)).

9.0 Reference

POP 105 – Decontamination of Field Equipment.

POP 106 –Investigative Derived Waste Management.

POP 402 – Monitoring Well Development.

POP 403 – Water Level Measurement in a Monitoring Well.

Monitoring Well Development – POP Number: 402

1.0 Scope and Method Summary

This Project Operating Procedure (POP) describes the basic techniques and general considerations to be followed for the development of newly installed monitoring wells and/or existing wells that may require redevelopment/rehabilitation.

Monitoring well development and/or redevelopment is necessary for several reasons:

- To restore hydraulic conductivity of the surrounding formations as they have likely been disturbed during the drilling process, or may have become partially plugged with silt,
- To remove drilling fluids (such as water and mud), when used, from the borehole and surrounding formations, and
- To remove residual fines from well filter materials and reduce turbidity of groundwater, thereby, reducing the chance of chemical alteration of groundwater samples caused by suspended sediments and providing representative groundwater samples.

Well development generally involves withdrawing water from a well using a pump, surge block or other suitable method such that, when completed effectively, the well is in good or restored hydraulic connection with the surrounding water bearing unit, produces minimal sediment, and is suitable for obtaining representative groundwater samples or for other testing purposes. Well development should be continued until the well produces water which is relatively free of sediments considering natural groundwater conditions and not be based solely on a specified volume of water removal.

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

2.0 Health and Safety Considerations

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, are addressed in the site specific Health and Safety Plan HASP. All work will be conducted in accordance with the HASP.

3.0 Interferences

Potential interferences could result from cross-contamination between monitoring wells. Minimization of cross-contamination will occur through the use of clean tools at each location, which will require decontamination of sampling equipment as per POP 105 – Decontamination of Field Equipment.

The process of installing a well necessarily disturbs the geologic formation. Wells will be developed appropriately as described in this POP. The wells will be allowed to stabilize a minimum of twenty-four hours, depending on grout type, after development before a well is sampled.

4.0 Equipment and Supplies

Well development can be performed using a variety of methods and equipment. The specific method chosen for development of any given well is governed by the purpose of the well, well diameter and materials, depth, accessibility, geologic conditions, static water level in the well, and type of constituents present, if any.

4.1 Pump Development

A pump is often necessary to remove large quantities of sediment-laden groundwater from a well after using the surge block. In some situations, the pump alone can be used to develop the well and remove the fines by over-pumping

(pumping at a high rate). Because the purpose of well development is to remove suspended solids from a well and the surrounding filter pack, the pump must be capable of moving some solids without damage. The preferred pump is a submersible pump, which can be used in both shallow and deep groundwater situations. A centrifugal pump may be used in shallow wells, but will work only where the depth to static groundwater is less than approximately 25 feet. Pumping may not be successful in low-yielding aquifer materials or in wells with insufficient hydraulic head.

4.2 Bailer Purging

A bailer is used to purge sediment-laden water from wells after using other devices such as a surge block. In some situations, the bailer can be used to develop a well by bailing and surging, often accompanied with pumping when appropriate. A bailer can be used for purging in situations where the depth to static water is greater than 25 feet and/or where insufficient hydraulic head is available for use of other development methods.

4.3 Surge Block Development

Surge blocks are commercially available for use with Waterra-type (or equivalent) pumping systems or may be manufactured using a "plunger" attached to a rod or pipe of sufficient length to reach the bottom of the well.

4.4 Other Materials

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Well Development Records, and/or field logbook and pen, and/or electronic data collector,
- Boring and well construction logs (if available),
- Plastic sheeting,
- Buckets,
- Paper towels,
- Trash bags,
- Power source (generator or 12-volt marine battery),
- Water level meter and/or well depth measurement device,
- Equipment decontamination supplies (as required by POP 105 – Decontamination of Field Equipment.),
- Health and safety supplies (as required by the HASP), and
- Appropriate containers, labels and materials to manage investigation-derived waste (IDW) (as specified in this SAP and as required by POP 106 – Investigative Derived Waste Management).

5.0 Procedures

5.1 General Preparation

Develop wells as soon as possible after construction, but no sooner than 12 hours after placing the annular seal. If bentonite chips are used as an annular seal, development should occur after 24 hours. If grout or neat cement is used, the time before well development should increase to 48 hours. The main concern is that the method being used for development does not interfere with allowing the grout to set. Develop the entire vertical screened interval using surge blocks, bailers, pumps, or other equipment which frequently reverses the flow of water through the well screen and prevents bridging of formation or filter particles.

Well construction logs should be reviewed to determine well construction characteristics. Formation characteristics should also be determined from review of available boring logs.

Provisions should be in place for collection and management of IDW relating to well development such as I development water and miscellaneous expendable materials generated during the development process. The collection of IDW in drums or tanks may be required depending on project-specific requirements.

The water level and well depth should be measured in accordance with POP 403 – Water Level Measurement in a

Monitoring Well and written on the field documentation (field log book, well development record, and/or electronic data collector). This information is used to calculate the volume of standing water (i.e., the well volume) within the well.

The quantity of drilling fluids such as mud or water, if used during the drilling and well installation process, should be recorded and a minimum of 3 times the volume of fluid introduced during drilling should be removed during the well development procedure.

5.2 Development Procedure

Development Method Selection

The construction details of each well shall be used to define the most suitable method of well development. Some consideration should be given to the potential concentrations of constituents in each well as this will impact IDW containment requirements.

The criteria for selecting a well development method include well diameter, total well depth, static water depth, screen length, the likelihood and potential concentrations of constituents, and characteristics of the geologic formation adjacent to the screened interval.

The limitations, if any, of a specific procedure are discussed within each of the following procedures.

Turbidity

Turbidity of development water will be observed during well development to monitor the progress of development. Visual observations of turbidity, such as silty or cloudy water, should be noted in the field documentation.

Bailer Procedure

Bailers shall preferably not be used for well development but may be used in combination with a surge block to remove sediment-laden water from the well.

- When using a bailer to purge well water; select the appropriate bailer, then tie a length of bailer cord onto the end of the bailer.
- Lower the bailer into the screened interval of the monitoring well. Sediment , if present, will generally accumulate within the lower portions of the well screen.
- The bailer may be raised and lowered repeatedly in the screened interval to further simulate the action of a surge block and pull silt through the well screen.
- Remove the bailer from the well and empty it into the appropriate storage container.
- Continue surging/bailing the well until relatively sediment-free water is obtained considering background aquifer conditions. If moderate to heavy sedimentation is still present, the surge block procedure should be repeated and followed again with bailing. If it is not possible to further reduce the turbidity, the well will be purged a minimum of 10 minutes after this determination.
- Visually check turbidity periodically.

Surge Block Procedure

A surge block effectively develops most monitoring wells.

- Insert the surge block into the well and lower it slowly to the level of static water. Start the surge action slowly and gently above the well screen using the water column to transmit the surge action to the screened interval. A slow initial surging, using plunger strokes of approximately 3 feet, will allow material that is blocking the screen to separate and become suspended.
- After 5 to 10 plunger strokes, sediment-laden water will be removed from the well using a pump integrated with the surge block, or removing the surge block to purge the well using a pump or bailer. Discharge the purged water into the appropriate storage container.
- Repeat the process. As development continues, slowly increase the depth of surging to the bottom of the well screen. For monitoring wells with long screens (greater than 10 feet) surging should be undertaken along the entire screen length in short intervals (3 feet) at a time. Continue this cycle of surging and purging until the water yielded by the well is free of visible suspended material. If it is not possible to further reduce the turbidity the well will be purged a minimum of 10 minutes after this determination.

- Visually check turbidity periodically.

Pump Procedure

Well development using only a pump is most effective in monitoring wells that will yield water continuously. Effective development cannot be accomplished if the pump has to be shut off to allow the well to recharge.

- When using a submersible pump or surface pump, set the intake of the pump or intake line in the center of the screened interval of the monitoring well.
- Pump a minimum of three well volumes of water from the well and raise and lower the pump line through the screened interval to remove any silt/laden water.
- Continue pumping water from the well until sediment-free water is obtained. This method may be combined with the manual surge block method if well yield is not rapid enough to extract silt from the surrounding formations. If it is not possible to further reduce the turbidity, the well will be purged a minimum of 10 minutes after this determination
- Visually check turbidity periodically.

5.3 Equipment Decontamination

All equipment that comes into contact with groundwater (e.g., surge block) will be decontaminated in accordance with POP 105 – Decontamination of Field Equipment before moving to the next location. If a disposable bailer is used, it should be properly discarded and disposed of in accordance with procedures for managing IDW outlined in this SAP.

6.0 Data and Records Management

All field information will be recorded in the field logbook, on a field collection form, or with an electronic data collector by field personnel. This information will include, at a minimum, well and sample designation, pre-sampling water level elevation, volume of purge water removed from each well, pre and post purge sampling parameters. In addition, the field project logbook will include notes regarding any problems or unusual conditions that may have occurred during the development process.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

7.0 Quality Assurance and Quality Control

Field personnel should follow specific quality assurance guidelines as outlined in the QAPP and/or this SAP.

A well will have been successfully developed when one or more of the following criteria are met:

- The sediment load in the well has been eliminated or greatly reduced based upon visual observation of turbidity or field measurement of turbidity.
- If it is not possible to further reduce the visible turbidity, the well will be purged a minimum of 10 minutes after this determination.

8.0 Personnel Qualifications and Training

Well development procedures vary in complexity and are commonly conducted by a subcontractor. It is recommended that initial development attempts be supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials may be present.

It is the responsibility of the field personnel to be familiar with the procedures outlined within this POP, quality assurance, and health and safety requirements outlined within this Sampling and Analysis Plan (SAP), the Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP). Field personnel are responsible for completing proper well development, decontamination of equipment, as well as proper documentation in the field logbook, field forms, or electronic data collector such as the Trimble Yuma® or equivalent (if appropriate).

9.0 Reference

POP 105 – Decontamination of Field Equipment.

POP 106 –Investigative Derived Waste Management.

POP 403 – Water Level Measurement in a Monitoring Well.

Water Level Measurement in a Monitoring Well – POP 403

1.0 Scope & Method Summary

This Project Operation Procedure (POP) describes the methods to be used for measuring depth to groundwater, non-aqueous phase liquid (NAPL) levels, and total depth of groundwater monitoring wells and piezometers. Similar procedures will also be used to measure the depth to water in surface water bodies from a stream gage.

Water and NAPL level and well depth measurements collected from monitoring wells, stream gages or piezometers are used to assess:

- The horizontal hydraulic gradient and the direction of groundwater flow,
- The vertical hydraulic gradient, if well nests are used (i.e., the direction of groundwater flow in the vertical plane),
- The calibration of a numerical groundwater flow model,
- The thickness of NAPL in a monitoring well, and
- Surface Water Elevation.

This information, when combined with other location-specific information, such as hydraulic conductivity or transmissivity, may be used to estimate the rate of constituent movement, etc. Total well depth measurements are also collected as an indicator of siltation within the well column and to calculate well volumes if necessary.

Measurements will involve measuring the depth to NAPL, depth to water or total well depth to the nearest 0.01 foot using an electronic probe (water level or product level meter). The depths within wells will be measured from the top of the inner casing at the surveyed elevation point as marked on the top of the inner casing.

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

2.0 Health and Safety

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

3.0 Interferences

Potential interferences could result in inaccurate readings if the sensor on the water or product level meter is dirty, or if the cable cannot be kept vertically upright (for example, from a bridge in the wind). Care shall be taken to keep the probe clean. If wells are not installed plumb, the probe may rest against the side of the well, which may be wet. Care shall be taken in measuring water or NAPL levels to reduce these interferences. If there is any concern that a particular reading may not be accurate, this shall be noted in the field documentation.

Pressure build up in a sealed flush mounted well may also cause initial water levels to be different than actual static water levels. In areas with low permeability and where sealed well caps (not vented) have been installed, wells should be left uncapped for a period ranging from a minute to ten minutes prior to measuring the water levels. However, one to ten minutes may not be sufficient for water levels to stabilize to atmospheric pressure in some wells and may require a number of readings over time to establish that equilibration and stabilization have been achieved. If any indication of gas build up in the well is observed upon removing the cap, such as a sound of air rushing into or out of the well, then a resting period should be allowed for the water level in the well to equilibrate with atmospheric pressure.

4.0 Equipment & Supplies

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, depending on field conditions.

4.1 Electronic Water Level Meter

Electronic water and product level meters consist of a spool of small-diameter cable (or tape) with a weighted probe attached to the end. When the probe comes in contact with the NAPL and/or water, an electrical circuit is closed, and a light and/or buzzer within the spool will signal the contact. A different tone or light is used to indicate NAPL and water. The probe shall be tested at the start of the field program to ensure proper operation.

4.2 Other Materials that may be required

- Health and safety supplies (as required by the HASP),
- Equipment decontamination materials (as required by *POP 105, Decontamination of Field Equipment*),
- Water and NAPL level field form or electronic data collector such as the Trimble Yuma® or equivalent (if applicable),
- Well construction records and previous monitoring data, and
- Field project logbook and pen.

5.0 Methods

5.1. Water and LNAPL Level/Well Depth Measurement

The water and NAPL level should be measured with a water or product level meter and written in the field logbook, field form, and/or electronic data collector. If the well depth is not known it should be measured with a water or product level meter and recorded in the field logbook, field form, and/or electronic data collector. This information is used to calculate groundwater elevations. All data will be maintained in the project files.

5.2 Equipment Decontamination

All equipment should be decontaminated prior to use and between well locations in accordance with *POP 105.*

5.3 Measurement Procedures

At each location (well, piezometer, etc.), determine the location of the surveyed elevation mark. For wells, general markings include either a notch in the riser pipe or a permanent ink mark on the riser pipe. For monitoring surface water levels, there may be a painted mark on an existing structure or the reference point must be known if not painted. All groundwater and NAPL level measurements should be collected prior to any ground water sampling.

To obtain a water and/or NAPL level measurement, lower the probe of a water or product level meter down into the water or NAPL until the audible sound of the unit is detected or the light on an electronic sounder illuminates. The light and/or sound will change as the NAPL probe passes through the NAPL and enters the water. In wells and piezometers, the probe shall be lowered slowly into the well to avoid disruption of formation water and creation of turbulent surface water within the well. At this time, the precise measurement should be determined (to nearest 0.01 feet) by repeatedly raising and lowering the tape to converge on the exact measurement. Obtain the reading from the surveyed elevation mark. When measuring water levels in wells installed in low permeability material, additional readings should be collected over 10 to 30 minutes to establish that equilibration has been achieved. This will be site or well dependent.

Record the water and NAPL level measurements as well as the location identification number, date, time, and weather conditions in the field logbook, field form and/or electronic data collector.

To measure the total depth of a well, lower the probe (turn down signal as appropriate) slowly to the bottom of the well. The depth may be difficult to determine for wells with “soft” or silty bottoms. It may be helpful to lower the probe until there is slack in the tape, and gently pull up until it feels as if there is a weight at the end of the tape. Observe the measurement (to the nearest 0.01 foot) of the tape against the surveyed elevation mark.

Record the total well depth in the field logbook, field form, and/or electronic data collector.

The meter will be decontaminated in accordance with POP 105. Generally, only that portion of the tape that enters the NAPL and water needs to be decontaminated. It is important that the measuring tape is never allowed to become kinked.

6.0 Data & Records Management

All field information will be recorded in the field logbook, on a field collection form, or in an electronic data collector such as the Trimble Yuma® or equivalent, by field personnel. Any problems or unusual conditions that may have occurred during the measurement process will be noted.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

7.0 Quality Assurance & Quality Control

Field personnel will follow specific quality assurance guidelines as outlined in the QAPP and/or this SAP. Where measured depths are not consistent with well records or previously measurements, the depths should be re-measured and verified.

8.0 Personnel Qualifications

Collecting water and NAPL level measurements is a relatively simple procedure requiring minimal training and a relatively small amount of equipment.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials may be present.

It is the responsibility of the field sampling personnel to be familiar with the sampling procedures outlined within this POP, and with specific sampling, quality assurance, and health and safety requirements outlined in this *Sampling and Analysis Plan (SAP)*, the *Quality Assurance Project Plan (QAPP)*, and the *Health and Safety Plan (HASP).* Field personnel are responsible for the proper use, maintenance, and decontamination of all equipment used for obtaining water and NAPL level measurements, as well as proper documentation in the field logbook, field forms, or electronic documentation (if appropriate).

9.0 References

POP 105 – Decontamination of Field Equipment.

Low Flow Groundwater Sampling – POP 404

1.0 Scope and Method Summary

This Project Operation Procedure (POP) describes the method for collecting valid and representative samples of groundwater from monitoring wells. This POP is written such that consideration of different sampling equipment may be used in different instances for collecting representative groundwater samples. The procedures presented in this POP are taken from the United States Environmental Protection Agency's documents; *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures* (U.S. EPA, 1996) and *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells* (U.S. EPA, 2010).

Groundwater sample collection generally involves purging the water that is non-representative of the formation water from a well prior to sample collection. Water quality indicator parameters are monitored until all parameters have stabilized for three successive readings. After the indicator parameters have stabilized, groundwater samples are then collected into the appropriate bottle or containers.

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

2.0 Health and Safety

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

3.0 Interferences

Potential interferences could result from cross-contamination between samples and sample locations. Minimization of cross-contamination will occur through the use of clean or new sampling tools at each location, which will require decontamination of sampling equipment following *POP 105 – Decontamination of Field Equipment.*

Potential interferences could result from the power source (e.g. generator). Minimization of contamination will occur through locating the power source a sufficient distance away from the well and sampling equipment and handling the power source with dedicated or disposable gloves.

4.0 Equipment and Supplies

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Well keys for secured wells;
- Road box (flush mount) keys;
- Purging and Sampling Pumps;
  - Peristaltic pump,
  - Submersible pump, and
  - Bladder pumps & extra bladders.
- Field Instruments;
  - Individual or multi-parameter meter(s) to measure temperature, pH, specific conductance, dissolved oxygen (DO), oxidation reduction potential (ORP), and turbidity, and
  - Water level meter.
- Tubing (Silicone and polyethylene (or as required for sampling, air supply, etc.));

- Previous Sample Collection Records or Electronic Data Collector such as Trimble Yuma® or equivalent;
- Disposable nitrile gloves
- Sample kit (i.e., bottles, labels, preservatives, cooler, ice);
- Filtration equipment (if necessary);
- Sample Chain of Custody forms (as required by POP 102 – Chain of Custody Procedures);
- Sample packaging and shipping supplies (as required by POP 103 – Packaging and Shipment of Environmental Samples);
- Waterproof marker or paint;
- Distilled or deionized water and dispenser bottles;
- Flow measurement cup or bucket;
- Buckets with lids;
- Instrument calibration solutions;
- Power source (generator or 12-volt marine battery) and extension cords with ground fault interrupt (GFI) protection;
- Air compressor or compressed gas for bladder pump;
- Paper towels;
- Plastic sheeting;
- Trash bags;
- Ziploc®-style bags;
- Equipment decontamination supplies (as required by POP 105 – Decontamination of Field Equipment);
- Health and safety supplies (as required by the HASP); and
- Field project logbook and pen.

5.0 Methods

5.1 Instrument Calibration

Field instruments will be calibrated according to the requirements of the QAPP and manufacturer’s specifications for each piece of equipment (e.g., *POP 502 – Water Quality Instrumentation*). Calibration records shall be recorded in the field logbook, appropriate field form, or electronic data collector.

5.2 Well Security and Condition

At each monitoring well location, observe the conditions of the well and surrounding area. Any issues with the following information should be noted on the groundwater sample collection record, field logbook, or electronic data collector.

- Condition of the well’s identification marker;
- Condition of the well lock and associated locking cap;
- Integrity of the well - protective outer casing, obstructions or kinks in the well casing, presence of water in the annular space, and the top of the interior casing; and
- Condition of the general area surrounding the well.

5.3 Measuring Point Determination

Identify an existing measuring point in accordance with *POP 403 – Water Level Measurement in a Monitoring Well.* Generally, the measuring point is referenced from the top of the well casing (TOC), not the protective casing. If no measuring point exists, a measuring point should be established on the north side of the well casing, clearly marked, and identified on field documentation (i.e., groundwater sample collection record, field logbook, or electronic data collector). The same measuring point should be used for subsequent sampling events.

5.4 Water Level Measurement

Water level measurements should be collected in accordance with *POP 403 – Water Level Measurements*. DO NOT collect total well depth until sample has been collected. Taking a total depth measurement will disturb sediments that have settled to the bottom of the well. This most likely will create high turbidity readings. The water level measurement should be entered on appropriate field documentation.

5.5 Well Purging Methods and Procedures

Objectives

Prior to sample collection, purging must be performed for all groundwater monitoring wells to remove water from within the casing and filter pack to ensure that a representative groundwater sample is obtained.

All groundwater samples will be collected using low flow (low-stress) purging and sampling procedures. The low-flow method emphasizes the need to minimize water level drawdown and low groundwater pumping rates to collect samples with minimal alterations to groundwater chemistry.

During well purging, the water level will be measured with a water level meter in accordance with *POP 403 – Water Level Measurement*. Water level drawdown and flow rate will be recorded on field documentation. A final purging rate will be selected that does not exceed 0.5 liters per minute (L/min) (typically between 0.1 L/min and 0.3 L/min), and results in little to no drawdown, ideally less than 0.3 feet.

The general types of non-dedicated equipment used for well purging include surface pumps and down-well pumps. Peristaltic pumps will generally be used unless the depth to water is too great, in which case submersible pumps will be used.

Purge water will be pumped through a flow-through cell and the following parameters will be measured: pH, specific conductivity, temperature, DO, ORP, and turbidity. These parameters will be measured with a water quality meter, calibrated according to the manufacturer's specifications (see *POP 502 - Water Quality Instrumentation*). A round of parameter measurements will be recorded approximately 10 minutes after the flow-through cell is full, and then every 3 to 5 minutes thereafter, until parameter values have stabilized.

Purging is considered complete and sampling may begin when all parameter values have stabilized and turbidity is below 10 Nephelometric Turbidity Units (NTU). Stabilization is considered to be achieved when three consecutive readings, taken at 3- to 5-minute intervals, are within the following limits:

- Turbidity : less than 10 NTU or ± 10%
- DO : ± 10%
- Specific Conductance : ± 3%
- Temperature : ± 3% or less than 0.5 degrees C
- pH : ± 0.1 standard units
- ORP : ± 10 millivolts

Every effort will be made to lower the turbidity to less than 10 NTU before sampling. If the turbidity cannot be reduced to below 10 NTU, the pumping rate will be reduced for 10 minutes. If turbidity still cannot be reduced below 10 NTU, samples may be collected if all other parameters are stable and the turbidity is stable (i.e. not improving). The condition will be noted on the field documentation. During hot and cold weather sampling, short tubing lengths should be utilized to avoid temperature changes and freezing of the tubing – if the sample temperature does not stabilize as the water flows through tubing exposed to ambient temperatures, this should be noted in the field notes.

If after one hour of purging, stabilization of parameters is not achieved, a sample will be collected and recorded in the field notes.

All purge water will be containerized and disposed per the project plan.

If a well purges dry, a groundwater sample will be collected when sufficient water has recharged the well. The condition will be noted on the field documentation.

5.6 Surface Pumps

General

Well purging using pumps located at the ground surface can be performed with a peristaltic pump if the water level in the well is within approximately 20 feet of the top of the well.

Peristaltic pumps provide a low rate of flow typically in the range of 0.075-0.750 L/min and a minimal disturbance of the water column.

Peristaltic Pump Procedure

Attach a new sample tube set-up to the peristaltic pump. Silicone tubing must be used through the pump head and must meet the pump head specifications. A second type of tubing (e.g., polyethylene) will be attached to the silicone tubing for use as the suction and discharge lines.

Measure the length of the suction line and lower it down the monitoring well until the end is located at the midpoint of the saturated screen and at least 2 feet above the bottom of the well to preclude excess turbidity from the bottom of the well. Start the pump and direct the discharge into a graduated bucket. Adjust the pumping rate with the speed control knob so that a smooth flowing discharge is attained.

Measure the pumping rate by recording the time required to fill a flow measurement cup or bucket. The pumping shall be monitored to assure continuous discharge. If drawdown causes the discharge to stop, the suction line will be lowered very slowly further down into the well until pumping restarts. The pumping rate will be adjusted so that drawdown is stabilized, ideally at a level less than 0.3 feet.

5.7 Down-Well Pumps

General

Groundwater withdrawal using non-dedicated down-well pumps may be performed with a submersible pump or a bladder pump.

Electric submersible pumps provide an effective means for well purging and in some cases sample collection. Submersible pumps are particularly useful for situations where the depth to water table is greater than 20 feet and where the depth or diameter of the well requires that a large purge volume be removed before sample collection.

A commonly available submersible pump, the Grundfos Redi-Flo2TM pump (or equivalent), is suited for operation in 2-inch or larger internal diameter wells. Pumping rates are adjusted to low-flow levels by adjusting the current to the pump motor rather than using a flow valve.

Bladder pumps may also be used. Bladder pumps usually consist of a stainless steel pump housing with an internal Teflon® or polyethylene bladder. Discharge and air line tubing is connected to the bladder pump to the air compressor and control unit. The pump is operated by lowering it into the water column to the midpoint of the well screen, then pulsing air into the bladder from the air compressor and pump controller unit. Pumps and controllers are often not interchangeable between manufacturers; therefore, it is usually necessary to have both items provided by the same manufacturer. Pump bladders are generally field-serviceable and replaceable.

A check of well condition shall be completed prior to inserting any down-well pump if the well has not been sampled for some time or if groundwater quality conditions are not known. The well condition check should include a check of the casing to determine if there are any obstructions.

Electric Submersible Pump Procedure

Slowly lower the submersible pump with attached discharge line into the monitoring well taking notice of any roughness or restriction within the well riser pipe. The inlet of the pump should be placed at the midpoint of the saturated monitoring well screen. The power cord should be attached to the discharge line with an inert material (i.e., zip-ties) to prevent the power cord from getting stuck between the pump, discharge line, and the well casing. Secure the discharge line and power cord to the well casing, using tape or a clamp, taking care not to crimp or cut either the discharge line or power cord.

Connect the power cord to the power source (i.e., rechargeable battery pack, auto battery, or generator) and turn the pump on. Voltage and amperage meter readings on the pump controller (if provided) should be monitored closely during purging. The operations manual for the specific pump used should be reviewed regarding changes in voltage/amperage and the potential impacts on pump integrity. The pumping rate will be adjusted so that drawdown is stabilized, ideally at a level less than 0.3 feet.

Bladder Pump Procedure

To operate the bladder pump system, the pump and discharge line should be lowered into the well until the inlet of the pump is at the midpoint of the saturated monitoring well screen. Secure the discharge and power lines to the well casing with a clamp. The air compressor should then be turned on to activate pumping. The pump controller is used to vary the discharge rate to the required flow. The pumping rate will be adjusted so that drawdown is stabilized, ideally at a level less than 0.3 feet.

5.8 Sample Collection Methods and Procedures

Objectives

Groundwater samples can be collected using similar methods employed for purging. In most cases during sampling, groundwater will be transferred to the appropriate containers directly from the discharge source. It is important that the tubing from the pump to the flow-through cell be disconnected prior to sample collection. During transfer, discharge tubing and other equipment shall not contact the inside of the sample containers.

Groundwater samples that may require filtration (if specified in the work plan), will be filtered in the field at the wellhead using a 0.45-micron (or other as specified), in-line filter.

Surface Pumps

Using the methods and procedures described in Section 6.5, groundwater samples will be collected from the peristaltic pump. Sample bottles shall be filled directly from the pump's discharge line (after tubing has been disconnected from the flow-through cell) and care shall be taken to keep the discharge tube from contacting the sample container.

Down-Well Pumps

Using the pump methods described in Section 6.6, groundwater samples should be collected from either the electric submersible or bladder pump directly from the discharge line (after tubing has been disconnected from the flow-through cell). Sample bottles will be filled directly from the discharge line of the pump.

Sample Handling and Preservation

- Cap and label the container. .
- Place the sample containers into a cooler and maintain on ice.
- Complete sample chain of custody and other documentation per *POP 102 – Chain of Custody Procedures.*
- Package the samples for shipment to the laboratory per *POP 103 – Packaging and Shipment of Environmental Samples.*

5.8 Equipment Decontamination

All equipment that comes into contact with groundwater (e.g., submersible pumps) will be decontaminated in accordance with *POP 105 – Decontamination of Equipment* protocol before moving to the next location. Dedicated or disposable equipment will not be decontaminated.]

6.0 Data & Records Management

Specific information regarding sample collection should be documented in several areas: the sample Chain of Custody Record; sample collection record, field logbook, or electronic data collector; and sample labels or tags. Additional information regarding each form of documentation is presented in the following paragraphs.

6.1 Sample Chain of Custody Record

This standard form requires input of specific information regarding each collected sample for laboratory analytical purposes, as specified in POP 102.

6.2 Sample Collection Record or Electronic Data Collector

The sample collection record requires input of specific information regarding the collection of each individual sample including sample identification, water quality parameters, collection method, and containers/preservation requirements. An electronic data collector such as a Trimble Yuma® may be used in place of or in addition to the sample collection record.

6.3 Field Logbook

The logbook should be dedicated to the project and should be used by field personnel to maintain a general log of activities throughout the sampling program. The logbook should be used in support of, and/or in combination with, the sample collection record or electronic data collector. Documentation within the logbook should be thorough and sufficiently detailed to present a concise, descriptive history of the sample collection process.

6.4 Sample Labels

Sample labels shall be completed at the time each sample is collected and attached to each sample container. Sample labeling will be conducted per this SAP and the QAPP. Labels will include the information listed below.

- Client or project name/project number,
- Sample number or designation,
- Analysis type,
- Preservative,
- Sample collection date,
- Sample collection time, and
- Sampler's name.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

7.0 Personnel Qualifications

Groundwater sample collection is a relatively involved procedure requiring formal training and a variety of equipment. It is recommended that initial sampling of groundwater wells be supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous materials may be present.

It is the responsibility of the field sampling personnel to be familiar with the sampling procedures outlined within this POP, and with specific sampling, quality assurance, and health and safety requirements outlined in this *Sampling and Analysis Plan (SAP)*, the *Quality Assurance Project Plan (QAPP)*, and the *Health and Safety Plan (HASP)*. Field personnel are responsible for the proper use, maintenance, and decontamination of all equipment used for obtaining water level measurements, as well as proper documentation in the field logbook, field forms, or electronic documentation (as appropriate).

8.0 Quality Assurance & Quality Control

Field personnel should follow specific quality assurance guidelines as outlined in the QAPP and/or this SAP.

Quality assurance requirements typically suggest the collection of a sufficient quantity of quality control (QC) samples such as field duplicate, equipment and/or field blanks and matrix spike/matrix spike duplicate (MS/MSD) samples. These requirements are outlined in the QAPP.

9.0 References

POP 102 – Chain of Custody Procedures.

POP 103 – Packaging and Shipment of Environmental Samples.

POP 105 – Decontamination of Field Equipment.

POP 403 – Water Level Measurement in a Monitoring Well

POP 502 – Water Quality Instrumentation

United States Environmental Protection Agency, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures (U.S. EPA April 1996.

United States Environmental Protection Agency, Region 1, Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, Revision No. 3 (U.S. EPA January 2010.

Headspace Analysis of VOCs in Unsaturated Soil Samples – POP 501

1.0 Scope and Method Summary

This Project Operating Procedure (POP) provides guidance for the headspace analysis to screen for volatile organic compounds (VOCs) in unsaturated soil samples using a Photoionization Detector (PID) (OVM®, MiniRAE®, or equivalent).

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans or on Field Modification Forms and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

2.0 Health and Safety

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, are addressed in the site specific Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

3.0 Interferences

Regardless of which gas is used for calibration, the instrument will respond to all analytes present in the sample that can be detected by the type of lamp used in the PID.

Moisture will generate a positive interference in the concentration measured for a PID and is characterized by a slow increase in the reading as the measurement is made. Care must be taken to minimize uptake of moisture to the extent possible. Refer to the manufacturers’ instructions for care, cleaning, and maintenance.

Uptake of soil into the PID must be avoided as it will compromise instrument performance by blocking the probe, causing a positive interference, or dirtying the PID lamp. Refer to the manufacturers’ instructions for care, cleaning, and maintenance.

The user should listen to the pitch of the sampling pump. Any changes in pitch may indicate a blockage and corrective action should be initiated.

Make sure readings are not collected near a vehicle exhaust or downwind of the drill rig exhaust.

Potential interferences could result from cross-contamination between sample locations. Change gloves between samples to avoid cross contamination. Also, minimize cross-contamination through the use of clean sampling equipment at each location. Decontamination of sampling equipment is acceptable; therefore non-disposable sampling equipment will be decontaminated according to *POP 105 – Decontamination of Field Equipment.*

4.0 Equipment & Supplies

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- PID (with correct sized lamp as determined by the Task Manager and communicated in the work plan),
- Ziploc® Bags or equivalent (either quart or gallon size) or glass jars (8 oz or 16 oz) with aluminum foil,
- Field Notebook or Soil Boring/Monitoring Well Log Sheet or digital capture device (such as Trimble® Yuma®),
- Pen with indelible ink (blue or black ink),
- Permanent marker,
- Personal protective equipment (PPE) and health and safety equipment as specified in the HASP.

5.0 Methods

5.1 Preparation

Review available project information to determine the types of organic vapors that will likely be encountered to select the right instrument. The correct ultraviolet (UV) light bulb must be selected according to the types of organic vapors that will likely be encountered. The energy of the UV light must equal or exceed the ionization potential of the organic molecules that the PID will measure. The *National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards* is one source for determining ionization potentials for different chemicals. Bulbs available for PIDs include 9.4 electron volts (eV), 10.6 (or 10.2) eV, and 11.7 eV bulbs. The 10.6 eV bulb is most commonly used as it detects a fairly large range of organic molecules and does not burn out as easily as the 11.7 eV bulb. The 9.4 eV bulb is the most rugged, but detects only a limited range of compounds. Under very humid or very cold ambient conditions, the window covering the UV light may fog up, causing inaccurate readings.

After selecting the correct instrument, calibrate the PID according to manufacture directions. Record background/ambient levels of organic vapors measured on the PID after calibration and make sure to subtract the background concentration (if any) from your readings. Check the PID readings against the calibration standard every 20 readings or at any time when readings are suspected to be inaccurate, and recalibrate, if necessary. Be aware that, after measuring highly contaminated soil samples, the PID may give artificially high readings for a time due to saturation.

5.2 Equipment Decontamination

If new Ziploc® bags or new glass jars will be used with each new sample, equipment decontamination will not be required. If previously used glass jars are used, all soil should be removed from the used jars and the jars should be rinsed out with tap water. The jars should be allowed to dry. Once dry, the jars should be checked with a PID. The previously used jars should only be re-used if the PID reading is 0.0 parts per million (ppm). Removed soil and rinse water should be managed according to *POP 106 – Investigative Derived Waste Management.*

5.3 Sampling Procedure - Ziploc® Bags

Place a quantity of soil in a top-sealing plastic bag and seal the bag immediately. The volume of soil to be used should be determined by the Task Manager or Field Task Manager. Ideally, the bag should be at least 1/10th-filled with soil and no more than half-filled with soil. Once the bag is sealed, shake the bag to distribute the soil evenly. If the soil is hard or clumpy, use your fingers to gently work the soil (through the bag) to break up the clumps. Do not use a sampling instrument or a rock hammer since this may create small holes in the plastic bag and allow organic vapors to escape. Alternatively, the sample may be broken up before it is placed in the bag. Use a permanent marker to record the following information on the outside of the bag:

- Site identification information (i.e., borehole number),
- Depth interval, and
- Time the sample was collected.

Headspace should be allowed to develop before organic vapors are measured with a PID. Allow the headspace to develop inside the bag for a minimum of five minutes. Equilibration time should be the same for all samples to allow an accurate comparison of organic vapor levels between samples. However, adjustments to equilibration times may be necessary when there are large variations in ambient temperature from day to day. When ambient temperatures are below 32 degrees Fahrenheit (°F) (0 degrees Celsius [°C]), headspace development should be within a heated building or vehicle. When heating samples, be sure there is adequate ventilation to prevent the build-up or organic vapors above action levels.

Following headspace development, open a small opening in the seal of the plastic bag. Insert the probe of the PID and seal the bag back up around the probe as tightly as possible, minimizing the air loss from the bag. Alternatively, the probe can be inserted through the bag to avoid loss of volatiles. If this alternative method is used, make sure the PID probe does not get clogged with plastic when puncturing the bag. Since PIDs are sensitive to moisture, avoid touching the probe to the soil or any condensation that has accumulated inside of the bag. Since the PID consumes organic vapors, gently agitate the soil sample during the reading to release fresh organic vapors from the sample. Analyze the sample with the PID for at least one minute, making note of the average and peak readings. Record the PID results (in ppm) in the field notebook, soil boring/monitoring well log, or digital capture device. Dispose of the soil with the rest of the investigation derived waste (IDW) in accordance with *POP 106 – Investigative Derived Waste Management.*

5.4 Sampling Procedure - Jars with Aluminum Foil

Half-fill a clean glass jar with the soil sample to be screened. Quickly cover the jar's opening with one or two sheets of clean aluminum foil and apply the screw cap to tightly seal the jar. Use a permanent marker to record the following information on the top of the foil seal or jar cap:

- Site identification information (i.e., borehole number),
- Depth interval, and
- Time the sample was collected.

Allow headspace development for at least five minutes. Equilibration time should be the same for all samples to allow an accurate comparison of organic vapor levels between samples. However, adjustments to equilibration times may be necessary when there are large variations in ambient temperature from day to day. Vigorously shake the jar for approximately15 seconds, both at the beginning and at the end of the headspace development period. When ambient temperatures are below 32°F (0 °C), headspace development should be within a heated area. When heating samples, be sure there is adequate ventilation to prevent the build-up of organic vapors above action levels.

Subsequent to headspace development, remove the jar lid and expose the foil seal. Quickly puncture the foil seal with the PID probe, to a point about one-half of the headspace depth. Exercise care to avoid uptake of water droplets or soil particulates. Analyze the sample with the PID for at least one minute, making note of the average and peak readings. Record the PID results (in ppm) in the field notebook, soil boring/monitoring well log, or digital capture device. Dispose of the soil with the rest of the IDW in accordance with *POP 106 – Investigative Derived Waste Management.*

6.0 Data & Records Management

All data generated (results and duplicate comparisons) will be recorded in the field notebook, electronic data collector, and/or on the field form. Any deviation from the outlined procedure will also be noted. Data to be recorded includes:

- Field conditions,
- Field personnel performing task,
- When the PID was calibrated (date/time) and calibration standard used,
- Background/ambient concentrations measured after PID calibration,
- Location of sample (i.e., bore-hole number),
- Depth interval of sample measured,
- Lithology of material measured, and
- PID readings (average and peak) and units of measure.

Note that if PID measurements are recorded on a boring log, it is not necessary to duplicate information in the column where the PID readings are recorded (e.g., borehole number, depth interval, lithology type).

All documentation will be stored in the project files and retained following completion of the project.

7.0 Personnel Qualifications

The Project Manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this POP and any associated work plan(s).

The field operator is responsible for verifying that the PID is in proper operating condition prior to use and for implementing the calibration and measurement procedures in accordance with this POP and any associated work plan(s).

It is the responsibility of the field staff to conduct headspace analysis in a manner which is consistent with this POP. Field staff will also record all pertinent data into a digital capture device, onto a boring log or into a field logbook.

8.0 References

POP 105 – Decontamination of Field Equipment

POP 106 – Investigative Derived Waste Management

Water Quality Instrumentation – POP 502

1.0 Scope and Method Summary

The purpose of this Project Operating Procedure (POP) is provide a framework for calibrating instruments used to measure water quality parameters for ground water and surface water. Water quality parameters include temperature, pH, dissolved oxygen (DO), conductivity/specific conductance, and oxidation reduction potential (ORP). Manufactures instructions will be used in place of this POP, where available.

This POP is written specifically for the YSI Model 6-Series Sondes (which include the 600R, 600XL, 600XLM, 6820, 6920 and 6600 models), and the YSI 650 MDS (Multi parameter Display System) display/logger. However, the general calibration processes discussed herein are applicable to the YSI Professional Plus and other manufactures sondes and displays/loggers (e.g., Horiba U-22, InSitu Troll 9500). Consult the manufacturer's instruction manuals for specific procedures.

It is expected that the procedures outlined in this POP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this POP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the POP will be documented in the project records and in subsequent reports.

2.0 Health & Safety

The health and safety considerations for the work associated with this POP, including both potential physical and chemical hazards, are addressed in the site specific Health and Safety Plan (HASP). All work will be conducted in accordance with the HASP.

Site investigation activities may involve physical and/or chemical hazards associated with exposure to water, sediment, or materials in contact with either water or sediment. When sediment sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project HASP.

3.0 Interferences

Each of the parameters measured with this procedure is subject to various interferences including cross-contamination, turbidity, aeration, and temperature fluctuations. Care must be taken to ensure that the instrument remains in a stable, controlled environment throughout the calibration and monitoring process and that the conditions under which the samples are analyzed are the same as those under which calibration is conducted.

4.0 Equipment and Supplies

The following equipment list contains materials which may be needed in carrying out the procedures contained in this POP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Thermometer (with National Institute of Standards and Technology [NIST] trace),
- pH Buffers of 4, 7, and 10 standard units,
- Conductivity standards (concentration dependent upon expected field conditions),
- Eureka ORP calibration standard (or similar)
- Zero Dissolved Oxygen Solution,
- Standard Deionized) Water provided by the laboratory,
- YSI Sonde with attached Turbidity, pH, Conductivity, DO, and ORP probes with clear flow-through cell or probe guard,
- YSI 650 MDS Multiparameter Display System (display logger),

- Sonde communications cable,
- Ring stand or similar capable of holding the sonde and flow-through cell upright during low-flow groundwater sampling,
- Gallon-size plastic freezer bags (e.g. Ziploc) to protect the MDS and the top of the Sonde from rain,
- Field data sheets, logbook, and/or electronic data capture device,
- Pen with indelible ink, and
- Personal protective equipment (PPE) and health and safety equipment as specified in the HASP.

5.0 Methods

All instrument probes must be calibrated before they are used to measure environmental samples, and the calibration should be checked daily, if possible, and whenever any anomalous readings are obtained.

5.1 Set-up

Before performing any calibration procedure the sonde and display/logger must warm-up for at least 15 minutes.

During the warm-up period, set the sonde up on a ring stand.

Prior to calibration, all instrument probes on the sonde must be cleaned according to the manufacturer’s instructions. Failure to perform this step can lead to erratic measurements. The probes must also be cleaned by rinsing with deionized (DI) water before and after immersing the probe in a calibration solution.

For each of the calibration solutions, provide enough volume so that the probe and the temperature sensor are sufficiently covered. Additional detail on volume is provided under each section and in the manufacturer’s instructions.

Check the battery level in the display/logger to see if recharging or new batteries are necessary.

Set up instrument display so that the following items are displayed:

- DO %,
- ORP (mV),
- DO (milligrams per liter (mg/L)),
- Specific Conductivity (milli per centimeters (mS/cm)),
- Turbidity ,
- Temperature (°C), and
- pH (standard units).

5.2 Temperature

For instrument probes that rely on the temperature sensor (pH, dissolved oxygen/specific conductance, and ORP), the sonde temperature sensor needs to be checked for accuracy against a thermometer that is traceable to the NIST. This accuracy check should be performed at least once a year, and the date and results of the check kept with the instrument. Temperature checks will be performed by the rental company for rented units, and by the AECOM Equipment Manager for AECOM-owned units. Prior to mobilizing, obtain the date and results of the check from the equipment room manager or check the outside of the case for rental units. If the check has not been performed within the past year, do not use the instrument. Document the date, results, and company that performed the check on the calibration log sheet or in the field logbook. Below is the verification procedure:

- Allow a container filled with water and the sonde to equilibrate to room temperature, and
- Place a thermometer that is traceable to the NIST into the water and wait for both temperature readings to stabilize.

Compare the two measurements. The instrument’s temperature sensor must agree with the reference thermometer within the accuracy of the sensor (+/- 0.15 degrees Celsius [°C]). If the measurements do not agree, the instrument may not be working correctly and the manufacturer should be contacted.

5.3 Dissolved Oxygen

The DO content in water is measured using a membrane electrode. The DO probe’s membrane and electrolyte solution should be inspected for any damage or air bubbles prior to calibration. If air bubbles or damage are present, replace the membrane according to manufacturer's suggestions. After changing the membrane, it is preferable to wait 12 hours before use to allow the membrane to equilibrate if time allows. If this is not possible, note this in the calibration log. The YSI 6-Series DO probe must be calibrated using the calibration cup provided with the sonde. Calibration of the DO probe requires inputting the current barometric pressure. The YSI 650 display/logger has a barometer within the unit and automatically provides this during the calibration procedure. The barometric pressure for all units onsite should be checked for agreement between units, or checking using the onsite barometer. Other display/loggers do not supply the barometric pressure, and this must be obtained from other sources. Do not use barometric pressure obtained from meteorology reports as these are usually corrected to sea level.

Calibration is performed using 100% saturated air, and checked immediately after with a solution of zero dissolved oxygen. The calibration check at the end of the day also uses 100% saturated air.

5.3.1 DO Calibration

- Place a small amount of water (<1/8 inch) in the bottom of the calibration cup. Engage only one thread of the calibration cap onto the sonde so that the DO probe is readily vented to the atmosphere. Take care to avoid touching the oxygen membrane with the calibration cups and flow-cell. The DO probe and thermistor must not be in contact with the water. Keep the instrument in run mode and wait approximately 15 minutes for the air in the calibration cup to become water-saturated (100% humidity at atmospheric pressure) and the temperature to equilibrate. Set up the remaining instruments and solutions in the meantime.
- When the temperature has stabilized, go to Calibrate mode - Calibrate DO%
- Record the temperature on the calibration log. Check the barometric pressure reading on the YSI versus the barometer and other YSIs present. Record the barometric pressure on the calibration log. (Note: barometric pressures presented in meteorological reports are generally corrected to sea level. These are not useful for calibrating the sonde, which requires uncorrected barometric pressure).
- When the DO% and temperature readings have stabilized for at least one minute, press "enter". Record the number that appears on the screen. Record also the DO mg/L value.
- Check the oxygen solubility at that pressure and temperature on the attached Table 1 and record under "Std temperature/pressure correction." The instrument DO reading should be comparable with the value on the table (within +0.2 mg/L). If not, recalibrate, or replace DO membrane.
- Make up the zero DO solution by filling the calibration cap with DI water, adding approximately 1 gram of sodium sulfite to supersaturate the solution. Add a few crystals of the cobalt chloride (purple salt) and stir. There should be solids on the bottom of the cap. Screw the cap tightly onto the YSI. Water should leak out to indicate that there is no air around the probes.
- Immediately after calibration, if the DO is at or below 0.50 mg/L, record the value on the calibration log. If the number stabilizes at a value > 0.50 mg/L, change the DO membrane. At the end of the day, if the DO is at or above 1.0 mg/L, note the failed criteria and the readings that are impacted, and repeat the analyses at the discretion of the field team leader.
- Remove the cap, and rinse the probes well with DI water. Blot the probes dry, carefully avoiding the DO membrane.

5.3.2 DO End-of-Day Check

- Follow the first step of the DO calibration in Section 5.3.1 above.
- Allow the DO % and temperature readings to stabilized for at least one minute. Record the number that appears on the screen. Record also the DO mg/L value.
- Check the oxygen solubility at that pressure and temperature on the attached Table 1 and record under "Std temp/pressure correction." The instrument DO reading should be comparable with the value on the table (within ±0.5 mg/L).

5.4 pH

The pH of a sample is determined electrometrically using a glass electrode. Choose the appropriate standards that will bracket the expected values at the sampling locations. A two or three-point calibration can be performed. Typically, a three-point calibration using standards pH 4, pH 7, and pH 10 will be required. A calibration check is performed immediately after calibration using the pH 7 standard and a criterion of ±0.05 pH units. A calibration check is also performed at the end of the day using the pH 7 standard and a criteria of 0.3 pH units.

5.4.1 pH Calibration

- Allow the buffered samples to equilibrate to the ambient temperature.
- Remove the calibration cap and clean all of the probes on the sonde with deionized water. Begin with pH 7.00. Wipe with Kimwipe and immerse all the probes in the 7.00 pH solution. Place enough pH 7.00 solution in the calibration cup to immerse the pH probe, reference junction, and thermistor. Return to calibration mode.
- Scroll to pH on the calibration menu. Select 3-pt calibration.
- Enter pH 7.00 when prompted for the first value, and press “enter”.
- When value is stable for approximately 30 seconds, press enter, and record the number that appears on the screen. The display will indicate that the calibration has been accepted and will prompt the analyst to enter a second pH value.
- Remove probes from solution. Rinse with DI water, wipe carefully, and put all probes in solution pH 4.00. Make sure that there is enough pH 4.00 buffer to immerse the pH probe, reference junction, and thermistor.
- Enter pH 4.00 when prompted for the second pH solution, press “enter”.
- Allow at least one minute for temperature equilibration. When value is stable for at least 30 seconds, press “enter”, and record the number that appears on the screen.
- Repeat steps 5, 6, and 7 for the pH 10.00 solution.
- Press “enter” or “esc” to go to calibration menu.
- Go to the run mode to perform a calibration check of the pH 7.00 solution. Rinse the probe and immerse in pH 7.00 solution. The reading should be within ± 0.05 standard units of 7.00. If not, recalibrate. Record the reading.

5.4.2 pH End-of-Day Check

- Go to the run mode to perform a calibration check of the pH 7.00 solution.
- Rinse the probe and immerse in pH 7.00 solution. Record the reading. The reading should be within ± 0.3 standard units of 7.00.
- If not, record on the impacted measurements that the pH calibration check criterion was not met.

5.5 Conductivity

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C. Note that the pH buffers are highly conductive and will adversely impact calibration of conductivity. Thoroughly rinse the probes after performing pH calibration, and then pre-rinse the probe with the conductivity solution to be used.

U.S. EPA recommends that conductivity be calibrated using standards that bracket the range of concentrations expected. Conductivities in groundwater frequently range below 1,000 µS/cm; however YSI does not recommend calibration with standards below 1,000 µS/cm because interference with the instrument from outside electrical noise (RF) may be a factor. Since the calibration for conductivity is a 1-point calibration, and expected conductivities will generally be less than 1,000 µS/cm, calibrate with the 1,000 µS/cm standard.

Conductivity Calibration

- Carefully rinse the probes in deionized water provided by the laboratory then in the first conductivity solution to be used.
- Immerse all probes completely in the conductivity calibration solution. Make sure that the thermistor is immersed, and the conductivity cell is immersed past the vent hole. Gently tap the side of the calibration cup to dislodge any air bubbles trapped inside the cell.
- Scroll to conductivity on the screen. Select calibrate to ms/cm. Check the standard solution on the temperature correction table (Table 1, below), or the table supplied with the bottle, and enter the corrected conductivity value. (Both should be in µs/cm.)
- Press “enter” and wait for the readings to stabilize. Press “enter”. Record the readings for conductivity and specific conductivity in the calibration log. Do not exit conductivity.
- Do not indicate “accept” when the calibration indicates “Out of Range.” Attempt to recalibrate. If the problem persists, use another instrument. Return the instrument to the vendor or equipment room.

- Perform a check of the calibration. Remove the probes from the solution. Rinse with the next conductivity solution. Immerse all probes in the conductivity calibration solution. Allow the number to stabilize and record the values for conductivity and specific conductivity in the calibration log. If the specific conductivity result is not within 5% of the value on the bottle, recalibrate. Remove probes from solution and rinse with DI water. Wipe dry.

Conductivity End-of-Day Check

- Rinse the probes with the conductivity solution then immerse all probes in the conductivity calibration solution.
- Allow the read out number to stabilize and record the values for conductivity and specific conductivity in the calibration log. If the specific conductivity result is not within 20% of the value on the bottle, note on the measurements obtained that the conductivity calibration check criteria were not met.
- Remove the probes from solution and rinse with DI water. Wipe dry.

5.6 Oxidation Reduction Potential

ORP will be checked for accuracy, and will only be field calibrated if the calibration check fails criteria.

ORP Calibration

- Switch to run mode. If not already pre-mixed, gently mix the ORP solution and open the packet. Put all but the DO probe in the ORP solution. Allow to stabilize and record reading. If reading is within ±10 millivolts (mV) of the actual value corrected for temperature (see table below), calibration is not required. If reading is not within ±10 mV of the actual value corrected for temperature (see table below), proceed to the next step below.
- Go to Calibration mode. Scroll to ORP and press “enter”. Enter ORP value (corrected for temperature - see above) and press “enter”. When the number is stable for 20 seconds, press “enter” and record the number. If instrument says “Out of Range,” do not accept the value: Use a different instrument. If a different instrument is not available, record the number and note that it is not within limits.

ORP End-of-Day Check

- Switch to run mode.
- Gently mix the ORP solution and open the packet. Put all but the DO probe in the ORP solution.
- Allow to stabilize and record reading. If reading is not within ±10 mV of the actual value corrected for temperature (see table below), note on the measurements affected that the criterion for ORP check was not met.

Instrument Shutdown

- Replace the storage cup with a wet sponge in the bottom over probes.
- Select run mode. Reset the parameters to the following:
  - pH,
  - specific conductivity,
  - ORP,
  - Temperature,
  - DO mg/L,
  - Shut off hand held display and return to case.

7.0 Data & Records Management

Calibration log sheets shall be used to document the details of instrument calibration and calibration checks.

The site logbook should be used to note when instrument calibration and instrument calibration checks were conducted, and should reference the calibration log sheets for details.

Readings measured by instruments that are subsequently found to be outside of criteria during the calibration check shall be documented on the sampling worksheet used to document the sample collection.

All field records will be maintained in the project files.

8.0 Personnel Qualifications

The Project Manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this POP and the project plans.

The field operator is responsible for verifying that the YSI is in proper operating condition prior to use and for implementing the calibration and measurement procedures in accordance with this POP and the project plan.

9.0 Quality Assurance and Quality Control

9.1 Quality Control

Criteria are summarized in Table 3, which is attached..

9.2 Pollution Prevention

Containers used to calibrate the probes shall be sized to use the smallest amount of standard possible but still accommodate all probes which need to be in the calibration solution such that they are adequately covered.

Conductivity and pH calibration solutions may be reused at the end of the day with caution if properly stored. However, a calibration check that reuses standard but does not meet criteria should be re-checked with fresh standard, and calibration should be conducted with fresh standards.

9.3 Waste Management

Unused calibration standards should be returned to the equipment room manager or equipment rental vendor for proper disposal and/or storage. Do not combine ORP standards with other standards since cyanide could be released. Used calibration standards should be disposed of in accordance with *POP 106 – Investigative Derived Waste Management.*

10.0 References

POP 106 – Investigative Derived Waste Management

YSI, Inc. (YSI). 2002. YSI Calibration Procedures: Profiling and Logging, www.water-monitor.com.

Part II
Quality Assurance Project Plan

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1 Project Description

1.1 Introduction

This Quality Assurance Project Plan (QAPP) is prepared to supplement the Remedial Investigation and Feasibility Study (RI/FS) Work Plan for the RI/FS at Pepco's Benning Road facility (the Site), located at 3400 Benning Road NE, Washington, D.C., and a segment of the Anacostia River adjacent to the Site. The general site location is shown on **Figure 1** of the Field Sampling Plan (FSP). Together, the Site and the adjacent segment of the River are referred to herein as the "Study Area". The RI/FS Study Area consists of a "landside" component which will focus on the Site itself, and a "waterside" component that will focus on the shoreline and sediments in the segment of the river adjacent to and immediately downstream of the Site. The landside and waterside areas of investigation are depicted in **Figure 2** of FSP.

The purpose of this QAPP is to present the organization, objectives, planned activities, and specific quality assurance/quality control (QA/QC) procedures associated with the RI activities to be conducted at the Site. Specific protocols for sampling, sample handling and storage, COC, and laboratory and field analyses are described herein. This QAPP has been prepared in accordance with the United States Environmental Protection Agency (USEPA) QAPP policy as presented in USEPA Requirements for Quality Assurance Project Plans (USEPA QA/R-5, March 2001). This QAPP (Part II of the Sampling and Analysis Plan) is also prepared in accordance with the outline provided in the Final RI/FS Scope of Work (SOW).

1.2 Project Background

The Site is one of several properties along the Anacostia River that are suspected sources of contamination. There have been ~~five~~ six* instances since 1985 in which materials containing polychlorinated biphenyls (PCBs) were released at the Site. In each case, Pepco promptly cleaned up the releases in accordance with applicable legal requirements. Nonetheless, it is suspected that these releases, and possibly other historical operations or activities at the Site, may have contributed to contamination in the river. In particular, a site inspection conducted for the USEPA in 2009 linked polycyclic aromatic hydrocarbons (PAH), PCBs, and inorganic constituents detected in Anacostia River sediments to potential historical discharges from the Site. The site inspection contractor also stated that currently the Site is properly managed and that any spills or leaks of hazardous substances are quickly addressed and, if necessary, properly remediated. The RI will evaluate all spills at the Site as necessary.

Pepco has agreed to perform the RI/FS pursuant to a consent decree that was entered by the U.S. District Court for the District of Columbia on December 1, 2011 (the Consent Decree). The Consent Decree documents an agreement between Pepco and the District of Columbia (District) which is part of the District's larger effort to address contamination in and along the lower Anacostia River. The purpose of the RI/FS is to (a) characterize environmental conditions within the Study Area, (b) investigate whether and to what extent past or current conditions at the Site have caused or contributed to contamination of the river, (c) assess current and potential risk to human health and environment posed by conditions within the Study Area, and (d) develop and evaluate potential remedial actions.

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

Pepco conducted several investigations and removal actions at the Site since 1985 (**Table 1** and **Figure 3** in the FSP). The USEPA conducted two studies, a Multi-media Inspection and a Comprehensive Environmental Liability and Compensation Act (CERCLA) Site Inspection, within the Study Area. In addition, the National Park Service (NPS) completed a remedial investigation at the adjacent Kenilworth Landfill and a Preliminary Assessment/Site Investigation (PA/SI) at Langston Golf Course. AECOM reviewed available information from these studies and other studies conducted in the River by various governmental and non-governmental organizations, and incorporated the findings into the Conceptual Site Model (CSM) and Work Plan development. Detailed information on previous investigations, geology, hydrogeology, hydrology, and site and area descriptions can be found in the RI/FS Work Plan.

The RI/FS will be overseen by the District Department of the Environment (DDOE) and will be performed in accordance with the USEPA *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Office of Solid Waste and Emergency Response (OWSER)* Directive 9355.3-01, dated October 1988, and other applicable USEPA and DDOE guidance documents.

1.3 Analytical Task Description

To accomplish the RI/FS objectives, the following field sampling tasks will be implemented:

- Landside surface and subsurface soil sampling and analysis from areas within the Site;
- Landside collection and analysis of groundwater from monitoring wells ;
- Waterside collection and analysis of surface water from the Anacostia River; and
- Waterside collection and analysis of sediments from the Anacostia River.

Tables 4 and **5** of the FSP summarize the analyses that will be performed on the samples collected at the Site as part of the RI/FS on the Landside and Waterside, respectively. In general, analyses to be performed by matrix are:

- Target Compound List (TCL) Volatile Organic Compounds (VOCs), TCL Semi-volatile Organic Compounds (SVOCs), Priority Pollutant Polycyclic Aromatic Hydrocarbons (PP PAHs or PAH16), TCL Organo-chlorine Pesticides (OCPs), TCL PCB-Aroclors, Target Analyte List (TAL) metals (total and dissolved for groundwater), Gasoline Range Organics (GRO), Diesel Range Organics/Oil Range Organics (DRO/ORO), and Polychlorinated Dibenzodioxins and Dibenzofurans (PCDDs/PCDFs) in soil and groundwater.
- TCL VOCs, TCL SVOCS, PP PAHs, TCL OCPs, TCL PCB-Aroclors or PCB-Homologs, TAL metals (total and dissolved), GRO, DRO/ORO, and PCDDs/PCDFs in surface water.
- TCL VOCs, TCL SVOCs, PP PAHs, TCL OCPs, TCL PCB-Aroclors or PCB-Homologs, TAL metals (total and dissolved), GRO, DRO/ORO, PCDDs/PCDFs, Acid Volatile Sulfide/Simultaneously Extracted Metals (AVS/SEM), and Grain Size in sediments.
- PCB-congeners (all 209) and an extended list of parent and alkyl PAHs may be performed on selected soil and sediment samples for forensic purposes.

2 Project Organization and Responsibilities

2.1 Project Schedule

A tentative project schedule is provided in the RI/FS Work Plan. According to the Consent Decree deadlines, field work must begin within 30 days of the approval of the Final RI/FS Work Plan, Health and Safety Plan (HASP), FSP and QAPP.

2.2 Project Organization

The responsibilities of key personnel are described below.

2.2.1 Management Responsibilities

Pepco Project Manager

As Pepco Project Manager, Ms. Mahvi's responsibilities include:

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

AECOM Project Manager

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

- Subcontractor procurement,
- Assignment of duties to project staff and orientation of the staff to the specific needs and requirements of the project,
- Ensuring that data assessment activities are conducted in accordance with the QAPP,

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

2.2.2 Quality Assurance Responsibilities

AECOM Project Quality Assurance (QA) Officer

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

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

AECOM Analytical Task Manager

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

2.2.3 Laboratory Responsibilities

Pending final procurement, TestAmerica is proposed to perform the chemical analyses of all samples as detailed in **Section 7.0**.

Laboratory Manager

The Laboratory Manager is ultimately responsible for the data produced by the laboratory. Specific responsibilities include:

- Implementing and adhering to the laboratory QA manual and all corporate policies and procedures within the laboratory,
- Approving the standard operating procedures (SOPs),
- Maintaining adequate staffing, and
- Implementing internal/external audit findings corrective actions.

Laboratory QA Coordinator

The Laboratory QA Coordinator reports to the Laboratory Manager. Specific responsibilities include:

- Approving SOPs,
- Assessing and maintaining the laboratory QA manual implementation within the facility operations,
- Recommending resolutions for ongoing or recurrent nonconformances within the laboratory,
- Performing QA assessments, and
- Reviewing and approving corrective action plans for nonconformances, tracking trends of nonconformances to detect systematic problems, and initiating additional corrective actions as needed.

Laboratory Project Manager

The TestAmerica Laboratory Project Manager is anticipated to be Ms. Carrie Gamber at TestAmerica-Pittsburgh. She will be the primary point of contact between the TestAmerica network laboratories and AECOM. The ECCS on-site mobile lab Project Manager will be Nick Nigro. Specific responsibilities of the Laboratory Project Manager include:

- Monitoring analytical and QA project requirements for a specified project,
- Acting as a liaison between the client and the laboratory staff,
- Reviewing project data packages for completeness and compliance to client needs, and
- Monitoring, reviewing, and evaluating the progress and performance of projects.

2.2.4 Field Responsibilities

AECOM Field Team Leader

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

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

AECOM Field Staff

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

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

3 Quality Assurance Objectives for Measurement

3.1 Data Quality Objectives

The field investigation activities are designed to characterize conditions in soil, groundwater, surface water and sediment, further refine the CSM, and collect data to support risk assessment and Natural Resource Damage Assessment (NRDA). Data gaps identified during the review of existing data were used to guide the scope of this investigation. Field investigation activities are divided into Landside and Waterside activities and are noted in **Section 1**. All field investigation activities will be conducted in accordance with the RI/FS Work Plan, the FSP, and the HASP, submitted under separate covers.

The data quality objectives (DQOs) for this investigation are:

- To characterize environmental conditions within the Study Area and refine the CSM
- To collect data to update existing Landside and Waterside datasets so the nature and extent of impacts can be better defined
- To collect data to determine whether and to what extent past or current conditions at the Site have caused or contributed to contamination of the Anacostia River
- To collect data within the Anacostia River to identify potential Site-related, near-Site and far-Site sources of contaminants of potential concern (COPCs) in sediment and surface water
- To collect hydraulic data to better understand the site-specific hydrogeology and evaluate the volumetric flux of groundwater to the Anacostia River
- To collect data to better understand sedimentation in the portion of the Anacostia River in Study Area
- To collect data to support performance of Human Health and Ecological Risk Assessments
- To collect data to support development and evaluation of remedial alternatives
- To collect data for NRDA evaluation

The Landside and Waterside DQO development process is presented in **Tables 2** and **3** of the FSP, respectively.

3.2 Data Quality Objectives for Measurement Data

3.2.1 Precision

Precision is a measure of the degree to which two or more measurements are in agreement. Field precision is assessed through the collection and measurement of field duplicates at a rate of one duplicate per twenty analytical samples, per matrix, per sampling technique.

Precision will be measured through the calculation of relative percent difference (RPD). The objective for field precision RPDs is < 30% RPD for aqueous samples, and < 50% RPD for solid samples, where results reported at greater than five times the reporting limit.

Precision in the laboratory is assessed through the calculation of RPD for duplicate samples, either as matrix spike/matrix spike duplicates (MS/MSDs) or as laboratory duplicates. The control limits provided in **Table 1** for each parameter will be utilized.

3.2.2 Accuracy

Accuracy is the degree of agreement between the observed value and an accepted reference or true value. Accuracy in the field is assessed through the use of trip blanks and equipment blanks and through the adherence to all sample handling, preservation, and holding time requirements. The objective for trip blanks and equipment blanks is that no target compounds are present above the reporting limit. Sampling preservation and holding time requirements are provided in **Table 4**.

Laboratory accuracy is assessed through the analysis of laboratory method blanks, and spiked samples such as MS/MSDs, laboratory control samples (LCSs), and surrogate compounds. Method blanks should not contain any target compounds above the reporting limits (RLs) which are quantitation limits based on the low point of calibration, or Estimated Minimum Level (EML) for all isotope dilution analytes. For spiked samples, the accuracy objectives, as measured by percent recoveries (%Rs), will be the control limits provided in **Table 1**.

3.2.3 Completeness

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

Field completeness is a measure of the amount of valid samples obtained during all sampling for the project. The field completeness objective is greater than 90 percent.

Laboratory completeness is a measure of the amount of valid measurements obtained from all the measurements taken in the project. The laboratory completeness objective is greater than 95 percent.

3.2.4 Sensitivity

Sensitivity of analytical data is demonstrated by laboratory RLs and Method Detection Limits (MDLs). The target RLs for the analytes to be analyzed are presented in **Tables 2** and **3**. The RLs for the actual samples may differ due to analytical dilutions, sample volume, or sample matrix.

Reporting limits were selected in part by consideration of the applicable screening levels which are risk based and used as Project Screening Limits (PSLs), and in part by consideration of the actual ability of the laboratory to attain reporting limits at the screening levels. Selected Ion Monitoring (SIM) will be performed for selected gas chromatography/mass spectrometry (GC/MS) analysis targets to obtain lower reporting and detection limits. Not all risk based target analyte PSLs are obtainable using the RLs of conventional USEPA methods.

To maximize the usability of the data, any analytes detected below the RLs and above the MDL will be reported by the laboratory as estimated (“J”) values for the following parameters: VOCs, SVOCs, OCPs, PCBs as Aroclors, GRO, DRO, ORO, and metals. For PCB congener and PCDD/PCDF analyses by high resolution mass spectrometry (HRMS), detected concentrations below the EML and above the Estimated Detection Limit (EDL) will be reported by the laboratory as estimated (“J”) values. EDLs are sample specific limits based on signal-noise ratio and will be used as the reporting detection limit for nondetect results.

3.2.5 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the protocols described in this QAPP are followed and that proper sampling techniques are used. Planned analytical data will be comparable when similar sampling and analytical methods are used as documented in the QAPP.

3.2.6 Representativeness

Representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary.

Representativeness is ensured through the design of the sampling program and will be satisfied by ensuring that the Work Plan and QAPP are followed and that proper sampling techniques are used. Within the laboratory, representativeness will be ensured by the use of appropriate methods, conformance to the approved analytical procedures, and adherence to sample holding times.

3.3 Special Training/ Certifications

3.3.1 Training

This investigation includes routine field sampling techniques, field measurements, and laboratory analyses. No specialized training is therefore necessary. Prior to starting work, personnel will be given instruction specific to the project, covering the following areas:

- Organization and lines of communication and authority,
- Overview of the scope of work,
- QA/QC requirements,
- Documentation requirements, and
- Health and safety requirements.

Instructions will be provided by the AECOM Project Manager, AECOM Field Team Leader, and AECOM Project QA Officer.

3.3.2 Certifications

The chemical analysis laboratories hold National Environmental Laboratory Accreditation Program (NELAP) accreditation.

3.4 Documents and Records

3.4.1 Project Files

The project files will be the central repository for all documents which constitute evidence relevant to sampling and analysis activities as described in this QAPP. AECOM is the custodian of the project files and will maintain the contents of the project files for the investigation, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports, and data reviews in a secured, limited access area and under custody of the AECOM Project Manager.

The project files will include at a minimum:

- Field logbooks,
- Field data and data deliverables,
- Photographs,
- Drawings,
- Sample collection logs,
- Laboratory data deliverables,
- Data validation reports,
- Data assessment reports,
- Access/Legal agreements with property owners,
- A copy of final plans and other documents,
- Progress reports, QA reports, interim project reports, etc.,
- All custody documentation (tags, forms, airbills, etc.)

Records will be retained for a minimum of 6 years or the duration requested by USEPA.

3.4.2 Field Records

Field logbooks will provide the means of recording the data collection activities and will be maintained in accordance with Project Operating Procedure (POP) 101 – Field Records located in **Appendix A** of the FSP. As such, entries will be described in as much detail as possible so that persons going to the facility could reconstruct a particular situation without reliance on memory.

Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in the project files when not in use. Each logbook will be identified by the project-specific document number.

The title page of each logbook will contain the following:

- Person to whom the logbook is assigned,
- The logbook number,
- Project name and number,
- Project start date, and
- End date.

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, and the signature of the person making the entry will be entered. The names of visitors to the site, field sampling or investigation team personnel, and the purpose of their visit, will also be recorded in the field logbook.

Field logbooks will be supplemented by standardized field measurement and sample collection forms. All measurements made and samples collected will be recorded. All entries will be made in permanent ink, signed, and dated and no erasures or obliterations will be made. If conditions are such that only a pencil can be used (e.g., extreme cold), the procedures for using a pencil in **Section 6.1** of POP 101 – Field Records must be followed. If an incorrect entry is made, the information will be crossed out with a single strike mark, which is initialed and dated by the sampler. Whenever a sample is collected, or a measurement is made, a detailed description of the sampling location, which includes compass and distance measurements, or, latitude and longitude information (e.g., obtained by using a global positioning system) will be recorded. The number of photographs taken of the sampling location, if any, will be noted. Equipment used to make measurements will be identified, along with the date of calibration.

3.4.3 Laboratory Records and Deliverables

Laboratory data reduction procedures will be performed according to the following protocol.

- All information related to analysis will be documented in controlled laboratory logbooks, instrument printouts, or other approved forms.
- All entries that are not generated by an automated data system will be made neatly and legibly in permanent, waterproof ink.
- Information will not be erased or obliterated. Corrections will be made by drawing a single line through the error and entering the correct information adjacent to the cross-out. All changes will be initialed, dated, and, if appropriate, accompanied by a brief explanation.
- Unused pages or portions of pages will be crossed out to prevent future data entry.
- Analytical laboratory records will be reviewed by the supervisory personnel on a regular basis and by the Laboratory QA Coordinator periodically, to verify adherence to documentation requirements.

On-site mobile laboratory turnaround time will be 24 hours. The standard fixed laboratory turnaround time will be 15 business days for all parameters except PCB congeners and PCDD/PCDFs. The turnaround time for PCB congener and PCDD/PCDF analysis is four weeks. The laboratory will provide a complete report in portable document format (PDF) format, and an electronic data deliverables (EDDs). The EDD will be provided as text files in AECOM-specific EQuIS® 4-file format. The PDF format data packages will be contract laboratory program (CLP)-

like reports containing QC summary forms and all raw data and will be completely paginated and bookmarked. All text in the reports should be electronically searchable.

4 Sampling Procedures

4.1 Sampling Design

A summary of the sample locations, types of samples collected, analyses to be performed, monitoring wells to be installed, and rationale for sample collection is presented in **Tables 4** and **5** of the FSP.

4.2 Sampling Methods

The reader is referred to FSP Section 5 and FSP Appendix A for details on field sampling methods and AECOM POPs, respectively.

4.3 QC sample collection

QC samples for laboratory analyses will include field duplicates, MS/MSDs, equipment blanks, trip blanks, and temperature blanks. These samples will be collected as described below:

<u>Field duplicates</u>

Field duplicates will be collected at a frequency of one field duplicate per 20 field samples, per matrix, per sampling technique. Field duplicates for solid samples will be collected by alternately filling two sets of identical sample containers from the interim container used to homogenize the sample. For soil VOC samples, the field duplicate will be collected using the collection device (e.g., sample coring device) from the same areas as the parent sample (i.e., soil VOC samples are not homogenized). For aqueous samples, the parent sample and field duplicate sample containers will be filled in an alternating fashion (i.e., one parent sample container filled, one field duplicate container filled. All field duplicates will be analyzed for the same parameters as their associated samples.

<u>MS/MSDs</u>

MS/MSD samples will be collected at a frequency of one for every 20 field samples, per matrix for all parameters except PCB congeners and PCDD/PCDFs. The HRMS isotope dilution methods for PCB congeners and PCDD/PCDFs include labeled analog spikes in every sample. For those samples designated as MS/MSDs, sufficient additional volume or mass (based on the laboratory’s requirements) will be collected.

Equipment blanks

Equipment blanks will be collected at a rate of one for every 20 field samples, per matrix, per sampling technique. Equipment blanks will be collected by pouring laboratory volatile organic analysis (VOA)-free water over the decontaminated sampling equipment, and collecting the rinsate into the appropriate sample containers. Equipment blanks will not be collected when dedicated sampling equipment is used (e.g., peristaltic pump with dedicated tubing).

Trip blanks

Trip blanks will be included with each shipment of groundwater and soil samples collected for VOC and GRO analyses. Trip blanks associated with groundwater samples will originate in the laboratory and will be prepared by filling two 40-mL VOA vials with laboratory VOA-free water and the chemical preservative, and sealing the vials with septum-lined caps (allowing no headspace). Trip blanks associated with soil VOC samples will consist of one set of the soil VOA vials (i.e., two low level VOA vials and one high level VOA vial). Trip blanks associated with soil GRO samples will consist of one soil GRO vial (i.e., one VOA vial containing methanol). Trip blanks will accompany the sample bottles to the site and will remain (unopened) in the shipping container until the sample bottles are received back at the laboratory.

Temperature blanks

Temperature blanks will be included in each cooler, allowing the laboratory to determine the temperature of the shipment without disturbing the field samples. Temperature blanks will be prepared by filling a plastic or glass vial with water.

5 Sample Custody

5.1 Sample Containers, Preservation, and Holding Times

Sample bottles and chemical preservatives will be provided by the laboratories. The containers will be cleaned by the manufacturer to meet or exceed all analyte specifications established in the latest USEPA's Specifications and Guidance for Contaminant-Free Sample Containers. Certificates of analysis will be provided with each lot of containers and maintained on file to document conformance to USEPA specifications. A summary of sample container, preservation, and holding time requirements is presented in **Table 4**.

5.2 Sample Labeling

Immediately upon collection, each sample will be labeled with an adhesive label. Samples will be assigned unique sample identifications. Each sample label will include the sample number, location, date/time of collection, and analysis. Each sample number will consist of a four part identification system that describes the sampling method, location ID, depth, and sample type, as described below:

- Sampling Method: This part is represented by a three letter code as follows:

Monitoring Well Soil	MWS
Monitoring Well Water	MWW
Soil Boring Soil	SBS
Soil Boring Water	SBW
Direct Push Soil	DPS

Direct Push Water	DPW
Surface Soil Sample	SUS
Sediment	SED
Surface Water	SUW

- Location: This will be a two digit code consisting of numbers, letters or a combination (e.g., 01, 15, C2).
- Sample Depth: Sample depth will be identified using a two digit number (e.g., 05 representing 5 feet below grade). Where sample depth involves an interval, this identifier identifies the starting depth of the interval only. The number "00" will represent surface samples.
- Sample Type: The last character of the sample ID will represent the sample type:
    N – Field sample
    R – Field duplicate
    Q – Quality control (QC) sample (e.g., equipment blank, trip blank)

- Equipment Blank – “EB” followed by date (e.g., EB-070110). If multiple EBs are collected on the same day for differing types of sampling equipment, numerical designations will be used to differentiate the type of equipment blank (e.g., EB01-070110, EB02-070110), with the type of sampling equipment associated with each type of equipment blank documented in the field log book (e.g., EB01-070110 collected from split spoon sampler, EB02-070110 collected from Geoprobe® cutting shoe)
- Trip Blank – “TB” followed by date (e.g., TB-070110). If multiple TBs are collected on the same day for multiple coolers of VOC samples, numerical designations will be used to differentiate the different trip blanks (e.g., TB01-070110, TB02-070110). The cooler specific chain-of-custody forms will document which VOC samples are associated with the trip blanks.

An example of a complete sample ID would be MWW0515N for the groundwater sample collected from monitoring well MW-5 at15 feet below grade. Another example would be SEDC200R representing duplicate of a surface sediment sample collected at grid node C2.

Samples being designated for matrix spike and matrix spike duplicate (MS/MSD) analysis will *not* include an identifier as part of the sample code, but will be identified as such on the chain-of-custody in the comments section on the same row as the parent sample.

5.3 Custody Procedures

Custody is one of several factors that are necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in two parts: field sample collection and laboratory analysis.
A sample is considered to be under a person's custody if

- the item is in the actual possession of a person;
- the item is in the view of the person after being in actual possession of the person;
- the item was in the actual physical possession of the person but is locked up to prevent tampering; and
- the item is in a designated and identified secure area.

5.3.1 Field Custody Procedures

The field sampler is personally responsible for the care and custody of the samples until they are transferred or dispatched properly. Field procedures have been designed such that as few people as possible will handle the samples. Field custody procedures will be performed according to POP 102 - Chain of Custody Procedures located in **Appendix A** of the FSP.

All sample containers will be identified by the use of sample labels with sample numbers, sampling locations, date/time of collection, and type of analysis. Sample labels will be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample tag because the pen would not function in freezing weather.

Samples will be accompanied by a properly completed COC form. The sample numbers and locations will be listed on the COC form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents the transfer of custody of samples from the sampler to another person, to the permanent laboratory, or to/from a secure storage location. An example COC form is presented as **Figure 1**. All sample shipments will be accompanied by the COC record identifying the contents. The original record will accompany the shipment, and the back copy will be retained by the sampler and placed in the project files.

Field samples will be packed and shipped to the laboratory according to POP 103 – Packaging and Shipment of Samples, located in **Appendix A** of the FSP. Samples will be properly packaged on ice at 4°C for shipment and dispatched to the laboratory for analysis, with a separate signed custody record enclosed in and secured to the inside top of each sample box or cooler. Shipping containers will be sealed and secured with strapping tape and custody seals for shipment to the laboratory. The custody seals will be attached to the front right and back left of the cooler and covered with clear plastic tape after being signed by field personnel. The cooler will be strapped shut with strapping tape in at least two locations.

If the samples are sent by common carrier, the waybill will be used. Waybills will be retained as part of the permanent documentation. Commercial carriers are not required to sign off on the custody forms since the custody forms will be sealed inside the sample cooler and the custody seals will remain intact.

5.3.2 Laboratory Custody Procedures

Samples will be received and logged in at the laboratory by a designated sample custodian or his/her designee. Upon sample receipt, the sample custodian will

- Examine the shipping containers to verify that the custody tape is intact,
- Examine all sample containers for damage,
- Determine if the temperature required for the requested testing program has been maintained during shipment and document the temperature on the COC form or in sample log-in records,
- Compare samples received against those listed on the COC,

- Verify that sample holding times have not been exceeded,
- Examine all shipping records for accuracy and completeness,
- Determine if sample pH is adequate and whether any adjustments were required (if applicable) and record sample receipt form,
- Sign and date the COC immediately (if shipment is accepted) and attach the waybill,
- Note any problems associated with the coolers and/or samples on the cooler receipt form and notify the Laboratory Project Manager, who will be responsible for contacting the client,
- Attach laboratory sample container labels with unique laboratory identification and analyses required, and
- Place the samples in the proper laboratory storage.

Following receipt, samples will be logged in according to the following procedure:

- The samples will be entered into the laboratory information management system (LIMS). At a minimum, the following information will be entered: project name or identification, unique sample identification numbers (both client and internal laboratory), type of sample, required analyses, and date and time of laboratory receipt of samples.
- The appropriate laboratory personnel will be notified of sample arrival.
- The completed COC, waybills, and any additional documentation will be placed in the project file.

Specific details of laboratory custody procedures for sample receiving, sample identification, sample control, and record retention are described in the Laboratory QA Manual and laboratory SOPs.

6 Calibration Procedures

6.1 Instrument/Equipment Testing, Inspection, and Maintenance

The field equipment for this project will include a photoionization detector (PID), an electronic water level indicator, and water quality instrumentation. AECOM field personnel will be responsible for ensuring that the instruments are properly functioning. At a minimum, this will entail checking the instrument prior to shipment to the field and performing daily operational checks and calibration as described in **Section 6.2**. Routine maintenance and trouble-shooting procedures will be performed as described in the manufacturer's instructions. Spare parts will be readily available on site or from the vendor.

Routine testing and preventive maintenance is performed by the laboratory as part of their QA program. Details on the type of checks, frequencies, and corrective actions are included in the Laboratory QA Manual.

6.2 Instrument/Equipment Calibration and Frequency

The field instrumentation requiring field calibration will include a PID, YSI water quality meter, and LaMotte turbidity meter. Calibration will be performed daily or anytime that the operator suspects that the instrument is not reading accurately according to POP 502 – Water Quality Instrumentation located in **Appendix A** of the FSP:

All calibrations and calibration checks will be documented in the field records. Calibration records will include the date/time of calibration/calibration check, name of the person performing the calibration, reference standard used, and the results of the calibration or check.

Calibration procedures for laboratory instruments will consist of initial calibrations, initial calibration verifications, and continuing calibration verification. The SOP for each analysis performed in the laboratory describes the calibration procedures, their frequency, acceptance criteria, and the conditions that will require recalibration. This information is summarized in **Table 7**.

The laboratory maintains documentation for each instrument, which includes the following information: instrument identification, serial number, date of calibration, analyst, calibration solutions, and the samples associated with these calibrations.

6.3 Inspection/ Acceptance of Supplies and Consumables

For this project, critical supplies for field activities will be tracked through AECOM's system in the following manner.

Critical Supplies and Consumables	Inspection Requirements and Acceptance Criteria	Responsible Individual
Sample bottles	Visually inspected upon receipt for cracks, breakage, and cleanliness. Must be accompanied by certificate of analysis.	Field Team
Chemicals and reagents	Visually inspected for proper labeling, expiration dates, appropriate grade	Field Team
Field measurement equipment	Functional checks to ensure proper calibration and operating capacity	Field Team
Sampling equipment	Visually inspected for obvious defects, damage, and contamination	Field Team

Supplies and consumables not meeting acceptance criteria will initiate the appropriate corrective action. Corrective measures may include repair or replacement of measurement equipment, and/or notification of vendor and subsequent replacement of defective or inappropriate materials. All actions will be documented in the project files.

The laboratory system of inspection and acceptance of supplies and consumable is documented in the Laboratory QA Manual.

7 Analytical Procedures

Soil, sediment, groundwater, and surface water samples will be analyzed by the NELAP-certified fixed and mobile laboratories listed below.

Groundwater, surface water, soil, and sediment samples collected for VOCs, SVOCs, OCPs, and metals will be analyzed by:

TestAmerica
301 Alpha Drive
Pittsburgh, PA 15238
412-963-7058

Groundwater and surface water samples collected for GRO, DRO/ORO will be analyzed by:

TestAmerica
3355 McLemore Drive
Pensacola, FL
850-474-1001

Soil and sediment samples collected for PCB-Aroclors and DRO/ORO will be analyzed at the on-site mobile laboratory by:

ECCS
2525 Advanced Road
Madison, WI 534718
608-221-8700

All PCB congener, alkylated PAH, and PCDD/PCDF analyses will be performed by:

TestAmerica
5815 Middlebrook Pike
Knoxville, TN 37921
865-291-3000

A summary of the sample locations, types of samples collected, and analyses to be performed is presented in **Tables 4** and **5** of the FSP. Details for conditional sample analyses are provided in the Work Plan.
EPA Method 1668A and EPA Method 8290A are ultratrace isotope dilution based HRMS analytical techniques. When concentrations exceed the calibration range in soil or sediment then results may be flagged E if they exceed

the upper confidence limit (UCL) but are within linear range of instrument response. If the labeled internal standard spike is diluted out during reanalysis then quantitation of target congeners may be performed by the internal standard method rather than true isotope dilution. These results will be appropriately qualified in the laboratory narrative and data validation reports.

Samples will be analyzed for the analytes listed in **Tables 2** and **3**. The laboratory analytical methods to be used are summarized in **Table 5**. Laboratory SOPs that will be utilized for the analyses are listed in **Table 6** and are included in **Appendix A** on CD-ROM. Note the laboratory SOPs are proprietary business information to be shared only with Pepco, AECOM, and DDOE.

8 Data Reduction, Validation and Reporting

8.1 Data Review, Verification, and Validation

All data generated through field activities, or through the analytical program, will be reduced, verified and/or validated prior to reporting. No data will be disseminated by AECOM or its subcontractors until it has been subjected to the procedures summarized below.

8.1.1 Field Data

Field data will be reviewed daily by the AECOM Field Team Leader to ensure that the records are complete, accurate, and legible and to verify that the sampling procedures are in accordance with the protocols specified in the Work Plan and QAPP.

8.1.2 Internal Laboratory Review

Prior to the release of any data from the laboratory, the data will be reviewed and approved by laboratory personnel. The review will consist of a tiered approach that will include reviews by the person performing the work, by a qualified peer, and by supervisory and/or QA personnel.

8.1.3 Validation of Analytical Data

AECOM's validation staff will perform validation on the data for all parameters as described in **Section 8.2.3** of this QAPP. The validation will primarily be based on information provided by the laboratory on QC summary forms, and will include minimal or no raw data review. At a minimum, the validation will include the following data elements:

- Agreement of analyses conducted with COC requests
- Holding times and sample preservation
- Initial and continuing calibrations and analytical sequence
- Mass spectrometer tuning (GC/MS only)
- Internal standard performance (GC/MS only)
- Laboratory blanks/equipment blanks/trip blanks
- Surrogate recoveries
- Laboratory control sample/laboratory control sample (LCS/LCSD) results
- Matrix spike/matrix spike duplicate (MS/MSD) results

- Laboratory duplicate results
- Field duplicate results
- Interference check sample results
- Inductively Coupled Plasma (ICP) serial dilution results
- Endrin/dichlorodiphenyltrichloroethane (DDT) breakdown check standard results (pesticides only)
- Labeled toxics/level of chlorination/window defining/labeled clean-up recoveries (PCB congeners only)
- Percent solids
- Quantitation limits and sample results (limited to evaluating dilutions and reanalyses)

8.1.4 Data Management

Data management operations include data recording, validation, transformation, transmittal, reduction, analysis, tracking, storage and retrieval.

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

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

Records of the checks are maintained on file.

Once all data quality checks are performed, the data will be exported to a variety of formats to meet project needs. Cross-tab tables showing concentrations by sample location will be prepared.

The project data will be maintained on a secure network drive, which is backed up regularly. Access to the data will be limited to authorized users and will be controlled by password access. Data will be retained in accordance with the requirements stated in **Section 3.4.1** of this QAPP.

8.2 Verification and Validation methods

8.2.1 Field Data Verification

Field records will be reviewed by the AECOM Field Team Leader to ensure that:

- Logbooks and standardized forms have been filled out completely and that the information recorded accurately reflects the activities that were performed.
- Records are legible and in accordance with good recordkeeping practices, i.e., entries are signed and dated, data are not obliterated, changes are initialed, dated, and explained.
- Sample collection, handling, preservation, and storage procedures were conducted in accordance with the protocols described in the QAPP, and that any deviations were documented and approved by the appropriate personnel.
- Field calibration, replicate and duplicate sample results are within acceptable ranges and any deviations were properly documented and approved by the appropriate personnel.

8.2.2 Laboratory Data Verification

Prior to being released as final, laboratory data will proceed through a tiered review process. Data verification starts with the analyst who performs a 100 percent review of the data to ensure the work was done correctly the first time. The data reduction and initial verification process must ensure that:

- Sample preparation and analysis information is correct and complete,
- Analytical results are correct and complete,
- The appropriate SOPs have been followed and are identified in the project records,
- Proper documentation procedures have been followed, and
- All nonconformances have been documented.

Following the completion of the initial verification by the analyst performing the data reduction, a systematic check of the data will be performed by an experienced peer or supervisor. This check will be performed to ensure that initial review has been completed correctly and thoroughly and will include a review of

- Adherence to the requested analytical method SOP,
- Correct interpretation of chromatograms, mass spectra, etc.,
- Correctness of numerical input when computer programs are used (checked randomly),
- Correct identification and quantification of constituents with appropriate qualifiers,
- Numerical correctness of calculations and formulas (checked randomly),

- Acceptability of QC data,
- Documentation that instruments were operating according to method specifications (calibrations, performance checks, etc.),
- Documentation of dilution factors, standard concentrations, etc.,
- Sample holding time assessment.

A third-level review will be performed by the Laboratory Project Manager before results are submitted to clients. This review serves to verify the completeness of the data report and to ensure that project requirements are met for the analyses performed. A narrative to accompany the final report will be prepared by the Laboratory Project Manager.

8.2.3 Validation of Analytical Deliverables

Validation of the data described in **Section 8.1.3** of this QAPP will be performed using EPA National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2010) and EPA National Functional Guidelines for Superfund Organic Methods Data Review (USEPA, 2008), modified as appropriate for non-CLP methods.

Upon completion of the validation, a report will be prepared. This report will summarize the samples reviewed, elements reviewed, any non-conformances with the established criteria, and validation actions (including application of data qualifiers). Data qualifiers will be consistent with the USEPA guidelines.

8.2.4 Verification during Data Management

All manually entered data (e.g., field data) will be proofed 100 percent against the original. Electronic data will be checked after loading against laboratory data sheets for completeness and spot checked for accuracy.

8.3 Reconciliation with User Requirements

8.3.1 Comparison to Measurement Objectives

The field and laboratory data collected during this investigation will be used to achieve the objectives identified in **Section 3.3** of this QAPP. The QC results associated with each analytical parameter for each matrix will be compared to the measurement objectives presented in **Section 3.3.2** of this QAPP. Only data generated in association with QC results meeting the stated acceptance criteria (i.e., data determined to be valid) will be considered usable for decision making purposes. Rejected data will be clearly indicated during validation and made unavailable for use.

Accuracy Assessment

One measure of accuracy will be %Rs, which is calculated for matrix spikes, surrogates, and LCSs. Percent recoveries for MS/MSD results will be determined according to the following equation:

$$\%R = \frac{(Amount\ in\ Spiked\ Sample - Amount\ in\ Sample)}{Known\ Amount\ Added} x100$$

Percent recoveries for surrogates and LCS results will be determined according to the following equation:

$$\%R = \frac{Experimental\ Concentration}{Known\ Amount\ Added} x100$$

An additional measure of accuracy is blank contamination. The blanks associated with this project include laboratory method blanks and field blanks (e.g., trip blanks). The results of the laboratory and field blanks will be compared to the objectives in stated **Table 1** of the QAPP. Failure to meet these objectives may indicate a systematic laboratory or field problem that should be investigated and resolved immediately. Associated data may be qualified and limitations placed on its use, depending on the magnitude of the problem.

Precision Assessment

The RPD between the matrix spike and matrix spike duplicate and field duplicate pair is calculated to compare to precision objectives (**Table 1** of this QAPP). The RPD will be calculated according to the following formula.

$$RPD = \frac{(Amount\ in\ Sample\ 1 - Amount\ in\ Sample\ 2)}{0.5\,(Amount\ in\ Sample\ 1 + Amount\ in\ Sample\ 2)} x100$$

Failure to achieve precision objectives may result in the associated data being qualified (**Section 8.2.3**) and limitations placed upon its use.

Completeness Assessment

Completeness is the ratio of the number of valid sample results to the total number of samples analyzed with a specific matrix and/or analysis. Following completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$Completeness = \frac{(number\ of\ valid\ measurements)}{(number\ of\ measurements\ planned)} x100$$

Failure to meet the completeness objective will require an assessment to determine if the missing or invalid data are critical to achieving the project objectives. Corrective actions may include resampling or re-analysis, depending on the type of problem, logistical constraints, etc.

8.3.2 Comparison to Project Objectives

In addition to the comparison described in **Section 8.3.1**, the data obtained will be both qualitatively and quantitatively assessed on a project-wide, matrix-specific, and parameter-specific basis. Factors to be considered in this assessment of field and laboratory data will include, but not necessarily be limited to, the following.

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

The effect of nonconformance (procedures or requirements) or noncompliant data on project objectives will be evaluated. Minor deviations from approved field and laboratory procedures and sampling approach will likely not affect the adequacy of the data as a whole in meeting the project objectives. The assessment will also entail the identification of any remaining data gaps and need to reevaluate project decision rules.

This assessment will be performed by the AECOM technical team, in conjunction with the AECOM Project QA Officer, and the results presented and discussed in detail in the final report.

9 Laboratory Quality Control

9.1 Laboratory QC samples

The analytical laboratories have a QC program in place to ensure the reliability and validity of the analysis performed at the laboratory. All analytical procedures are documented in writing as SOPs and each SOP includes the minimum requirements for the procedure. The internal QC checks differ slightly for each individual procedure and are outlined in the SOPs included in **Appendix A**. In general they include:

- Blanks (method, reagent/preparation, instrument)
- MS/MSDs
- Surrogate spikes (organic analyses)
- Laboratory duplicates
- LCSs
- Internal standard area counts (GC/MS analyses and ICP/mass spectrometry analysis)
- Endrin/DDT breakdown check standard results (OCP only)
- Calibration check compounds
- Interference checks (ICP analysis)
- Serial dilutions (ICP analysis)
- Labeled analog spike recovery (PCB congeners, PAHs by ID0016, and PCDD/PCDFs only)

The control limits for precision and accuracy will be those listed in **Table 1**.

9.2 Assessment/oversight

9.2.1 Assessment

The types of planned assessments pertinent to this program include technical surveillance audits (TSAs) of field and laboratory activities, data package audits, and data validation audits.

<u>Field Activity TSA</u>

If requested by the AECOM Project Manager, a TSA of field activities may be conducted by the AECOM Project QA Officer or his/her designate. The TSA includes an examination of field sampling records, field measurement results, field instrument operating and calibration records, sample collection, handling, and packaging procedures, QA procedures, COC, sample documentation, etc. If significant deficiencies are noted, follow-up audits will be conducted.

During the audit, the auditor will keep detailed notes of audit findings. Preliminary results of the audit will be reviewed with the AECOM Field Team Leader while on site to ensure that deficiencies adversely affecting data quality are immediately identified and corrective measures initiated. Upon completion of the audit, the AECOM Project QA Officer will prepare a written audit report, which summarizes the audit findings, identifies deficiencies and recommends corrective actions. This report will be submitted to the AECOM Project Manager, who will be responsible for ensuring that corrective measures are implemented and documented. The results of the audit process will be included in the QA reports to management.

Laboratory TSA

Laboratory TSAs are conducted periodically by AECOM's QA staff as part of their analytical subcontractor monitoring program. The laboratory TSA includes a review of the following areas:

- QA organization and procedures,
- Personnel training and qualifications,
- Sample log-in procedures,
- Sample storage facilities,
- Analyst technique,
- Adherence to laboratory SOPs and project QAPP,
- Compliance with QA/QC objectives,
- Instrument calibration and maintenance,
- Data recording, reduction, review, and reporting, and
- Cleanliness and housekeeping.

Preliminary results of the systems audit will be discussed with the Laboratory Manager, Laboratory Project Manager, and Laboratory QA Coordinator. A written report that summarizes audit findings and recommends corrective actions will be prepared and submitted to the Laboratory Manager for response, and to the AECOM Project Manager. The results of the audit, including resolution of any deficiencies, will be included in the QA reports to management.

9.2.2 Response Actions

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out-of-limit QC performance that can affect data quality. Corrective action can occur during field activities, laboratory analyses, and data assessment. All corrective action proposed and implemented should be documented in the QA reports to management. Corrective action should only be implemented after approval by the AECOM Project Manager, or his designate.

The DDOE Project Manager will be notified of significant issues that potentially impact the achievement of the project objectives.

Field Corrective Action

Corrective action in the field may be needed when the sample network is changed (i.e., more/less samples, sampling locations other than those specified in the QAPP, etc.), or when sampling procedures and/or field analytical procedures require modification, etc. due to unexpected conditions. The field team may identify the need for corrective action. The AECOM Field Team Leader will approve the corrective action and notify the AECOM Project Manager. The AECOM Project Manager, in consultation with the AECOM Project QA Officer, will approve the corrective measure. The AECOM Field Team Leader will ensure that the corrective measure is implemented by the field team.

Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods. The AECOM Project QA Officer will identify deficiencies and recommend corrective action to the AECOM Project Manager. Implementation of corrective actions will be performed by the AECOM Field Team Leader and field team. Corrective action will be documented in QA reports to the project management team.

Corrective actions will be implemented and documented in the field record book. Documentation will include:

- A description of the circumstances that initiated the corrective action,
- The action taken in response,
- The final resolution, and
- Any necessary approvals.

No staff member will initiate corrective action without prior communication of findings through the proper channels.

Laboratory Corrective Action

Corrective action in the laboratory may occur prior to, during, and after initial analyses. A number of conditions such as broken sample containers, multiple phases, low/high pH readings, and potentially high concentration samples may be identified during sample log-in or analysis. Following consultation with laboratory analysts and supervisory personnel, it may be necessary for the Laboratory QA Coordinator to approve the implementation of corrective action. If the nonconformance causes project objectives not to be achieved, the AECOM Project Manager will be notified.

These corrective actions are performed prior to release of the data from the laboratory. The corrective action will be documented in both the laboratory's corrective action files, and in the narrative data report sent from the laboratory to the AECOM Project Manager. If the corrective action does not rectify the situation, the laboratory will contact the AECOM Project Manager, who will determine the action to be taken and inform the appropriate personnel.

Corrective Action during Data Review and Data Assessment

The need for corrective action may be identified during either data review or data assessment. Potential types of corrective action may include resampling by the field team or reinjection/reanalysis of samples by the laboratory. These actions are dependent upon the ability to mobilize the field team and whether the data to be collected is necessary to meet the required QA objectives. If the AECOM data reviewer or data assessor identifies a corrective action situation, the AECOM Project Manager will be responsible for informing the appropriate personnel.

9.2.3 Reports to Management

QA reports will be submitted to the AECOM Project Manager to ensure that any problems identified during the sampling and analysis programs are investigated and the proper corrective measures taken in response. The QA reports will include (where applicable):

- All results of field and laboratory audits,
- A summary of revisions to the QAPP,
- Results of any performance evaluation (PE) or split samples,
- Problems noted during data validation and assessment, and
- Significant QA/QC problems, recommended corrective actions, and the outcome of corrective actions.

QA reports will be prepared by the AECOM Project QA Officer and submitted on an as-needed basis.

10 References

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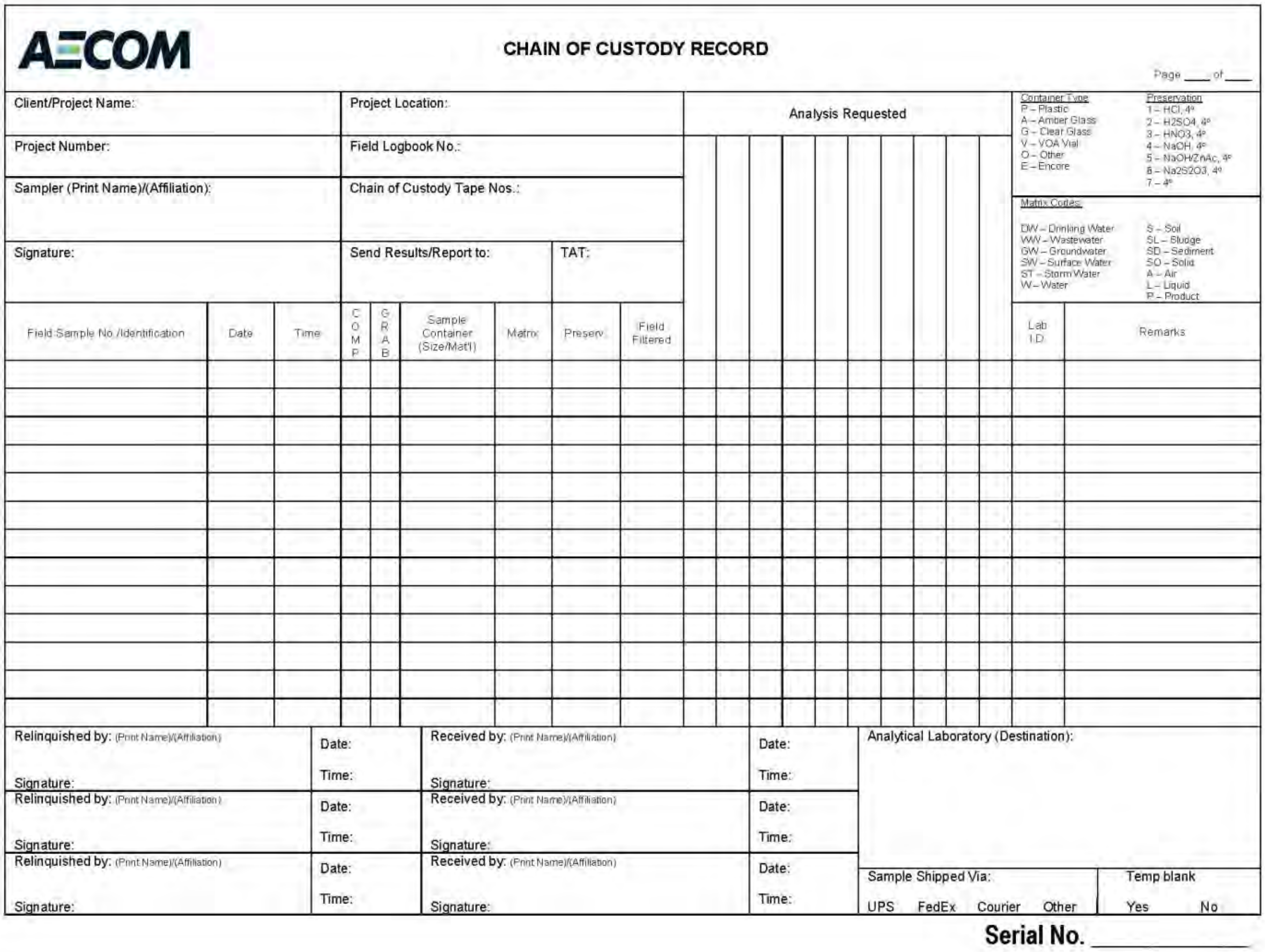
United States Environmental Protection Agency, 2006. *Quality Staff. Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4. EPA/240/B-06/001. February.

United States Environmental Protection Agency, 2002. *Quality Staff. EPA Guidance for Quality Assurance Project Plans*, EPA QA/G-5. EPA/240/R-02/009. December.

United States Environmental Protection Agency, 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*, Interim Final, EPA-540-G-89-004. October.

Figures

Figure 1. Example of AECOM Chain of Custody Form



AECOM

CHAIN OF CUSTODY RECORD

Page ____ of ____

Client/Project Name:

Project Location:

Project Number:

Field Logbook No.:

Sampler (Print Name)/(Affiliation):

Chain of Custody Tape Nos.:

Signature:

Send Results/Report to:

TAT:

Analysis Requested

Container Type
- P – Plastic
- A – Amber Glass
- G – Clear Glass
- V – VOA Vial
- O – Other
- E – Encore

Preservation
- 1 – HCl, 4°
- 2 – H2SO4, 4°
- 3 – HNO3, 4°
- 4 – NaOH, 4°
- 5 – NaOH/ZnAc, 4°
- 6 – Na2S2O3, 4°
- 7 – 4°

Matrix Codes:
- DW – Drinking Water
- WW – Wastewater
- GW – Groundwater
- SW – Surface Water
- ST – Storm Water
- W – Water
- S – Soil
- SL – Sludge
- SD – Sediment
- SO – Solid
- A – Air
- L – Liquid
- P – Product

Field Sample No./Identification	Date	Time	COMP	GRAB	Sample Container (Size/Mat'l)	Matrix	Preserv.	Field Filtered											Lab I.D.	Remarks

Relinquished by: (Print Name)/(Affiliation) Signature:	Date: Time:	**Received by:** (Print Name)/(Affiliation) Signature:	Date: Time:	Analytical Laboratory (Destination):
Relinquished by: (Print Name)/(Affiliation) Signature:	Date: Time:	**Received by:** (Print Name)/(Affiliation) Signature:	Date: Time:	
Relinquished by: (Print Name)/(Affiliation) Signature:	Date: Time:	**Received by:** (Print Name)/(Affiliation) Signature:	Date: Time:	Sample Shipped Via: UPS FedEx Courier Other Temp blank Yes No

Serial No. ______________

Tables

Table 1. Field and Laboratory QC

QC Sample→	Field Duplicate	MS/MSD	LCS/LCSD	MS/MSD	LCS/LCSD	Surrogate Spikes	Laboratory Method Blanks	Equipment Rinsate Blanks and/or Trip Blanks	Cooler Temperature Blanks
DQI	Precision			Accuracy - Bias			Accuracy-Bias/ Contamination		Accuracy-Bias/Preservation
VOCs	Soil RPD ≤ 50%; Aqueous RPD ≤ 30%	See laboratory % recovery limits in Appendix B					Target analytes < RL*	Target analytes < RL	4°C ± 2°C
SVOCs							Target analytes < RL*	Target analytes < RL	
OCPs							Target analytes < RL	Target analytes < RL	
PCBs - Aroclors							Target analytes < RL	Target analytes < RL	
PCBs - Congeners							Target analytes < EML	Target analytes < EML	
PCDD/PCDFs							Target analytes < EML	Target analytes < EML	
Metals		Matrix Duplicate Soil RPD ≤ 35%;aqueous RPD ≤ 20%	NA	75-125%	Soil- vendor control limits; aqueous 80-120%	NA	Target analytes < RL	Target analytes < RL	
GRO		RPD ≤ 50%	RPD ≤ 25%	40 – 140%; nonane 30 – 140%	40 – 140%; nonane 30 – 140%	40 -140%	Target analytes < RL	Target analytes and ranges < RL	
DRO/ORO		RPD ≤ 50%	RPD ≤ 25%	60 – 140%	70 – 130%	60-140%	Target analytes < RL	Target analytes and ranges < RL	

*VOCs and SVOCs: Common laboratory contaminants should be <5x RL
DQI – Data Quality Indicator
NA Not applicable
MS/MSDs not applicable PCB – congener analyses
Note all limits are subject to change based on final laboratory selection and required annual laboratory QC limit updates.

Table 2. Analyte lists and reporting limits for soil and groundwater (all parameters except PCB – congeners and PCDDs/PCDFs).

	Project Screening Limits[1]				Laboratory Limits[2]			
	Water (ug/L)		Solids (mg/Kg)		Water (ug/L)		Solids (mg/Kg)	
Parameter	**GW**	**SW**	**SO**	**SE**	**RL**	**MDL**	**RL**	**MDL**
VOCs by SW-846 8260B								
1,1,1-Trichloroethane	NV	1.10E+01	3.80E+03	7.00E-02	1.00E+00	2.86E-01	5.00E-03	4.86E-04
1,1,2,2-Tetrachloroethane	4.00E+01	4.00E+00	2.80E+00	1.36E+00	1.00E+00	2.00E-01	5.00E-03	7.18E-04
1,1,2-Trichloro-1,2,2-trifluoroethane	NV	NV	1.80E+04	NA	1.00E+00	3.20E-01	5.00E-03	1.07E-03
1,1,2-Trichloroethane	1.60E+02	1.60E+01	6.80E-01	4.00E-01	1.00E+00	2.01E-01	5.00E-03	8.31E-04
1,1-Dichloroethane	nv	4.70E+01	1.70E+01	2.00E-02	1.00E+00	1.16E-01	5.00E-03	5.75E-04
1,1-Dichloroethene	7.10E+04	2.50E+01	1.10E+02	1.00E-01	1.00E+00	2.96E-01	5.00E-03	8.48E-04
1,2,3-Trichlorobenzene	7.00E+02	8.00E+00	4.90E+01	1.10E-02	1.00E+00	1.54E-01	5.00E-03	8.45E-04
1,2,4-Trichlorobenzene	7.00E+02	7.00E+01	2.70E+01	1.10E-02	1.00E+00	2.71E-01	5.00E-03	8.82E-04
1,2-Dibromo-3-chloropropane	NV	NV	6.90E-02	NA	1.00E+00	1.41E-01	5.00E-03	7.49E-04
1,2-Dibromoethane	NV	NV	1.70E-01	NA	1.00E+00	1.80E-01	5.00E-03	8.63E-04
1,2-Dichlorobenzene	1.30E+04	2.00E+02	9.80E+02	3.00E-02	1.00E+00	1.52E-01	5.00E-03	7.98E-04
1,2-Dichloroethane	3.70E+02	3.70E+01	2.20E+00	2.00E-02	1.00E+00	2.12E-01	5.00E-03	6.13E-04
1,2-Dichloropropane	1.50E+02	1.50E+01	4.70E+00	2.00E-03	1.00E+00	9.48E-02	5.00E-03	5.43E-04
1,3-Dichlorobenzene	1.90E+03	2.00E+02	1.20E+01	3.00E-02	1.00E+00	1.05E-01	5.00E-03	6.56E-04
1,4-Dichlorobenzene	1.90E+03	1.90E+02	1.20E+01	3.00E-02	1.00E+00	2.06E-01	5.00E-03	6.37E-04
1,4-Dioxane	NV	NV	1.70E+01	1.19E-01	2.00E+02	3.43E+01	1.00E+00	2.76E+02
2-Butanone	NV	1.40E+04	2.00E+04	3.50E+01	5.00E+00	5.48E-01	5.00E-03	8.82E-04
2-Hexanone	NV	9.90E+01	1.40E+02	5.82E-02	5.00E+00	1.59E-01	5.00E-03	6.90E-04
4-Methyl-2-pentanone	NV	1.70E+02	5.30E+03	2.51E-02	5.00E+00	5.28E-01	5.00E-03	6.53E-04
Acetone	NV	1.50E+03	6.30E+04	9.90E-03	5.00E+00	2.50E+00	2.00E-02	5.00E-03
Benzene	5.10E+02	5.10E+01	5.40E+00	1.00E-02	1.00E+00	1.05E-01	5.00E-03	6.75E-04
Bromochloromethane	NV	NV	6.80E+01	NA	1.00E+00	1.80E-01	5.00E-03	6.88E-04
Bromodichloromethane	1.70E+02	1.70E+01	1.40E+00	NA	1.00E+00	1.30E-01	5.00E-03	5.61E-04
Bromoform	1.40E+03	1.40E+02	2.20E+02	7.50E+01	1.00E+00	1.91E-01	5.00E-03	4.42E-04
Bromomethane	1.50E+04	1.50E+03	3.20E+00	1.37E-03	1.00E+00	3.13E-01	5.00E-03	7.39E-04
Carbon disulfide	NV	9.20E-01	3.70E+02	8.51E-04	1.00E+00	2.12E-01	5.00E-03	5.12E-04
Carbon tetrachloride	1.60E+01	1.60E+00	3.00E+00	1.70E-01	1.00E+00	1.37E-01	5.00E-03	4.46E-04
Chlorobenzene	1.60E+04	1.60E+03	1.40E+02	3.00E-02	1.00E+00	1.35E-01	5.00E-03	7.57E-04
Chloroethane	NV	NV	6.10E+03	NA	1.00E+00	2.15E-01	5.00E-03	1.55E-03
Chloroform	4.70E+03	4.70E+02	1.50E+00	2.00E-02	1.00E+00	1.71E-01	5.00E-03	5.85E-04
Chloromethane	NV	NV	5.00E+01	NA	1.00E+00	2.83E-01	5.00E-03	8.52E-04
cis-1,2-Dichloroethene	NV	NV	2.00E+02	2.00E-01	1.00E+00	2.37E-01	5.00E-03	7.03E-04
cis-1,3-Dichloropropene	NV	NV	8.30E+00	NA	1.00E+00	1.87E-01	5.00E-03	6.78E-04
Cyclohexane	NV	NV	2.90E+03	NA	1.00E+00	2.54E-01	5.00E-03	3.71E-04
Dibromochloromethane	1.30E+02	1.30E+01	3.30E+00	NA	1.00E+00	1.37E-01	5.00E-03	7.10E-04
Dichlorodifluoromethane	NV	NV	4.00E+01	NA	1.00E+00	1.93E-01	5.00E-03	6.66E-04

Table 2. Analyte lists and reporting limits for soil and groundwater (all parameters except PCB – congeners and PCDDs/PCDFs).

	Project Screening Limits[1]				Laboratory Limits[2]			
	Water (ug/L)		Solids (mg/Kg)		Water (ug/L)		Solids (mg/Kg)	
Parameter	**GW**	**SW**	**SO**	**SE**	**RL**	**MDL**	**RL**	**MDL**
Ethylbenzene	2.10E+04	4.00E+01	2.70E+01	3.00E-02	1.00E+00	2.27E-01	5.00E-03	6.43E-04
Isopropylbenzene	NV	2.60E+00	1.10E+03	8.60E-02	1.00E+00	1.64E-01	5.00E-03	6.79E-04
Methyl acetate	NV	NV	1.00E+05	NA	1.00E+00	1.38E-01	5.00E-03	9.01E-04
Methylcyclohexane	NV	NV	2.90E+03	NA	1.00E+00	2.61E-01	5.00E-03	7.25E-04
Methylene chloride	NV	5.90E+02	3.10E+02	1.80E-02	1.00E+00	1.49E-01	5.00E-03	6.72E-04
Methyl-tert-butyl ether	NV	1.11E+04	2.20E+02	1.00E+02	1.00E+00	1.83E-01	5.00E-03	7.48E-04
o-Xylene	NV	3.50E+02	3.00E+02	8.90E-02	1.00E+00	1.09E-01	5.00E-03	7.79E-04
p+m-Xylene	NV	NV	2.60E+02	NA	2.00E+00	4.06E-01	1.00E-02	1.47E-03
Styrene	NV	7.20E+01	3.60E+03	2.00E-01	1.00E+00	9.66E-02	5.00E-03	7.05E-04
Tetrachloroethene	3.30E+01	3.30E+00	4.10E+01	2.00E-03	1.00E+00	1.49E-01	5.00E-03	6.80E-04
Toluene	1.50E+05	6.00E+02	4.50E+03	1.00E-02	1.00E+00	1.50E-01	5.00E-03	7.30E-04
trans-1,2-Dichloroethene	1.00E+05	1.00E+04	6.90E+01	2.00E-01	1.00E+00	1.70E-01	5.00E-03	5.96E-04
trans-1,3-Dichloropropene	NV	5.50E-02	8.30E+00	NA	1.00E+00	1.48E-01	5.00E-03	5.98E-04
Trichloroethene	3.00E+02	NV	2.00E+00	NA	1.00E+00	1.43E-01	5.00E-03	6.58E-04
Trichlorofluoromethane	NV	1.10E+04	3.40E+02	NA	1.00E+00	1.99E-01	5.00E-03	9.19E-04
Vinyl chloride	2.40E+01	2.40E+00	1.70E+00	1.00E-02	1.00E+00	2.27E-01	5.00E-03	4.69E-04
SVOCs by SW-846 8270C (with low level PAHs)								
1,1-Biphenyl	NV	1.40E+01	2.10E+01	1.22E+00	1.00E+00	4.15E-02	3.30E-02	2.98E-03
1,2,4,5-Tetrachlorobenzene	NV	1.10E+00	1.80E+01	1.00E-02	1.00E+00	6.51E-02	3.30E-02	2.53E-02
2,2’-Oxybis(1-chloropropane)	6.50E+06	6.50E+04	2.20E+01	NA	2.00E-01	1.97E-02	6.70E-03	7.20E-04
2,3,4,6-Tetrachlorophenol	NV	1.20E+00	1.80E+03	1.00E-02	1.00E+00	1.35E-01	3.30E-02	2.14E-02
2,4,5-Trichlorophenol	NV	3.60E+03	6.20E+03	1.00E-02	1.00E+00	1.53E-01	3.30E-02	3.56E-03
2,4,6-Trichlorophenol	2.40E+01	2.40E+00	6.20E+01	1.00E-02	1.00E+00	1.75E-01	3.30E-02	4.99E-03
2,4-Dichlorophenol	2.90E+03	1.10E+01	1.80E+02	1.00E-02	2.00E-01	3.34E-02	6.70E-03	6.69E-04
2,4-Dimethylphenol	8.50E+03	2.00E+02	1.20E+03	2.90E-02	1.00E+00	8.52E-02	3.30E-02	5.22E-03
2,4-Dinitrophenol	5.30E+04	5.30E+03	1.20E+02	6.21E-03	5.00E+00	6.13E-01	1.70E-01	3.97E-02
2,4-Dinitrotoluene	3.40E+01	3.40E+00	5.50E+00	4.16E-02	1.00E+00	5.36E-02	3.30E-02	2.69E-03
2,6-Dinitrotoluene	5.30E+04	3.40E+00	6.20E+01	4.16E-02	1.00E+00	7.97E-02	3.30E-02	3.44E-03
2-Chloronaphthalene	1.60E+04	2.00E+02	8.20E+03	2.50E-01	2.00E-01	1.51E-02	6.70E-03	6.96E-04
2-Chlorophenol	1.50E+03	1.00E+02	5.10E+02	5.50E-02	1.00E+00	1.65E-01	3.30E-02	2.73E-03
2-Methylnaphthalene	NV	4.70E+00	2.20E+02	2.02E-02	2.00E-01	1.22E-02	6.70E-03	6.00E-04
2-Methylphenol	NV	1.30E+01	3.10E+03	5.10E-03	1.00E+00	8.62E-02	3.30E-02	2.33E-03
2-Nitroaniline	NV	NV	6.00E+02	NV	5.00E+00	3.52E-01	1.70E-01	1.49E-02
2-Nitrophenol	8.60E+06	1.92E+03	1.80E+04	1.33E-02	1.00E+00	1.71E-01	3.30E-02	3.68E-03
3& 4-Methylphenol	NV	2.80E-02	3.80E+00	1.27E-01	1.00E+00	9.02E-02	3.30E-02	3.27E-03
3,3'-Dichlorobenzidine	2.80E-01	NV	8.60E+01	NV	1.00E+00	1.12E-01	3.30E-02	3.53E-03
3-Nitroaniline	NV	2.80E+02	4.90E+00	1.04E-01	5.00E+00	3.21E-01	1.70E-01	1.37E-02
4,6-Dinitro-2-methylphenol	2.80E+03	1.50E+00	NV	1.23E+00	5.00E+00	2.20E-01	1.70E-01	1.34E-02

Table 2. Analyte lists and reporting limits for soil and groundwater (all parameters except PCB – congeners and PCDDs/PCDFs).

Parameter	Project Screening Limits[1]				Laboratory Limits[2]			
	Water (ug/L)		Solids (mg/Kg)		Water (ug/L)		Solids (mg/Kg)	
	GW	SW	SO	SE	RL	MDL	RL	MDL
4-Bromophenyl phenyl ether	NV	NV	6.20E+03	1.50E+01	1.00E+00	6.35E-02	3.30E-02	2.90E-03
4-Chloro-3-methyl phenol	1.50E+03	2.32E+02	8.60E+00	1.46E-01	1.00E+00	7.54E-02	3.30E-02	3.07E-03
4-Chloroaniline	NV	NV	NV	NV	1.00E+00	8.85E-02	3.30E-02	2.67E-03
4-Chlorophenyl phenyl ether	NV	5.43E+02	6.20E+03	5.10E-03	1.00E+00	5.03E-02	3.30E-02	3.71E-03
4-Nitroaniline	NV	NV	8.60E+01	NV	5.00E+00	1.72E-01	1.70E-01	1.35E-02
4-Nitrophenol	8.60E+06	6.00E+01	1.80E+04	1.33E-02	5.00E+00	6.47E-01	1.70E-01	1.22E-02
Acenaphthene	9.90E+03	5.00E+01	3.30E+03	6.71E-03	2.00E-01	1.44E-02	6.70E-03	6.41E-04
Acenaphthylene	9.90E+03	4.84E+03	3.30E+03	5.87E-03	2.00E-01	1.52E-02	6.70E-03	7.64E-04
Acetophenone	NV	NV	1.00E+04	NV	1.00E+00	8.00E-02	3.30E-02	2.74E-03
Anthracene	4.00E+05	4.00E+04	1.70E+04	1.00E-02	2.00E-01	1.51E-01	6.70E-03	6.53E-04
Atrazine	NV	1.80E+00	7.50E+00	2.00E-04	1.00E+00	8.92E-02	3.30E-02	3.25E-03
Benzaldehyde	NV	NV	1.00E+04	NV	1.00E+00	1.50E-01	3.30E-02	5.00E-03
Benzo(a)anthracene	1.80E-01	1.80E-02	2.10E-01	3.19E-02	2.00E-01	1.47E-02	6.70E-03	8.36E-04
Benzo(a)pyrene	1.80E-01	1.80E-02	2.10E+00	1.57E-02	2.00E-01	1.34E-02	6.70E-03	6.68E-04
Benzo(b)fluoranthene	1.80E-01	1.80E-02	2.10E+00	1.04E+01	2.00E-01	1.57E-02	6.70E-03	1.05E-03
Benzo(g,h,i)perylene	4.00E+04	7.64E+00	1.70E+03	1.70E-01	2.00E-01	1.51E-02	6.70E-03	6.64E-04
Benzo(k)fluoranthene	1.80E-01	NV	2.10E+01	2.72E-02	2.00E-01	5.47E-02	6.70E-03	1.35E-03
bis(2-Chloroethoxy)methane	NV	1.10E+04	1.80E+02	NV	1.00E+00	5.81E-02	3.30E-02	2.20E-03
bis(2-Chloroethyl)ether	5.30E+00	NV	1.00E+00	3.52E+00	2.00E-01	2.51E-02	6.70E-03	8.95E-04
bis(2-Ethylhexyl)phthalate	2.20E+01	1.60E+01	1.20E+02	1.00E-01	2.00E+00	1.25E+00	6.67E-02	5.39E-03
Butyl benzyl phthalate	1.90E+04	1.90E+01	9.10E+02	1.00E-01	1.00E+00	1.42E-01	3.30E-02	4.56E-03
Caprolactam	NV	NV	3.10E+04	NV	5.00E+00	1.19E+00	1.70E-01	2.52E-02
Carbazole	NV	NV	2.20E+03	NV	2.00E-01	1.58E-02	6.70E-03	6.15E-04
Chrysene	1.80E-01	1.80E-02	2.10E+02	2.68E-02	2.00E-01	1.40E-02	6.70E-03	7.94E-04
Dibenzo(a,h)anthracene	1.80E-01	1.80E-02	2.10E-01	6.22E-03	2.00E-01	1.55E-02	6.70E-03	7.42E-04
Dibenzofuran	NV	3.70E+00	1.00E+02	5.10E+00	1.00E+00	6.17E-02	3.30E-02	3.28E-03
Diethyl phthalate	4.40E+05	2.10E+02	4.90E+04	5.30E-01	1.00E+00	1.46E-01	3.30E-02	3.64E-03
Dimethyl phthalate	1.10E+07	3.00E+00	4.90E+04	1.00E+00	1.00E+00	7.65E-02	3.30E-02	3.63E-03
Di-n-butyl phthalate	4.50E+04	1.90E+01	6.20E+03	1.10E-01	1.00E+00	1.25E-01	3.30E-02	4.18E-03
Di-n-octyl phthalate	NV	2.20E+01	6.20E+03	1.00E-01	1.00E+00	2.07E-01	3.30E-02	3.52E-03
Fluoranthene	1.40E+03	1.40E+02	2.20E+03	3.15E-02	2.00E-01	1.62E-02	6.70E-03	7.13E-04
Fluorene	5.30E+04	5.30E+03	2.20E+03	1.00E-02	2.00E-01	2.16E-02	6.70E-03	8.79E-04
Hexachlorobenzene	2.90E-03	2.90E-04	1.10E+00	1.40E-03	2.00E-01	1.83E-02	6.70E-03	7.11E-04
Hexachlorobutadiene	1.80E+02	1.00E+01	2.20E+01	2.65E-02	2.00E-01	1.66E-02	6.70E-03	7.47E-04
Hexachlorocyclopentadiene	1.10E+04	5.00E-01	3.70E+02	9.01E-01	1.00E+00	5.18E-02	3.30E-02	3.60E-03
Hexachloroethane	3.30E+01	3.30E+00	4.30E+01	1.03E+00	1.00E+00	6.28E-02	3.30E-02	2.40E-03
Indeno(1,2,3-cd)pyrene	1.80E-01	4.31E+00	2.10E+00	1.73E-02	2.00E-01	1.99E-02	6.70E-03	6.87E-04
Isophorone	9.60E+03	9.60E+02	1.80E+03	4.32E-01	1.00E+00	6.44E-02	3.30E-02	2.51E-03

Table 2. Analyte lists and reporting limits for soil and groundwater (all parameters except PCB – congeners and PCDDs/PCDFs).

	Project Screening Limits[1]				Laboratory Limits[2]			
	Water (ug/L)		Solids (mg/Kg)		Water (ug/L)		Solids (mg/Kg)	
Parameter	**GW**	**SW**	**SO**	**SE**	**RL**	**MDL**	**RL**	**MDL**
Naphthalene	NV	6.00E+02	1.80E+01	1.47E-02	2.00E-01	1.40E-02	6.70E-03	5.75E-04
Nitrobenzene	6.90E+03	6.90E+02	2.40E+01	1.45E-01	2.00E+00	8.43E-02	6.67E-02	2.78E-03
N-Nitroso-di-n-propylamine	5.10E+00	NV	2.50E-01	NV	2.00E-01	3.08E-02	6.70E-03	7.82E-04
N-Nitrosodiphenylamine	6.00E+01	2.10E+02	3.50E+02	2.68E+00	1.00E+00	8.53E-02	3.30E-02	3.09E-03
Pentachlorophenol	3.00E+01	3.00E+00	2.70E+00	1.00E-02	1.00E+00	6.63E-02	3.30E-02	2.98E-03
Phenanthrene	4.00E+05	4.00E-01	1.70E+04	1.87E-02	2.00E-01	4.27E-02	6.70E-03	1.06E-03
Phenol	8.60E+06	4.00E+00	1.80E+04	4.80E-02	2.00E-01	5.81E-02	6.70E-03	7.88E-04
Pyrene	4.00E+04	2.50E-02	1.70E+03	4.43E-02	2.00E-01	1.57E-02	6.70E-03	6.75E-04
Pesticides by SW-846 8081B (low level)								
4,4’-DDD	3.10E-03	3.10E-04	7.20E+00	3.54E-03	1.30E-03	6.70E-04	8.33E-05	1.09E-05
4,4’-DDE	2.20E-03	2.20E-04	5.10E+00	3.16E-03	1.30E-03	7.90E-04	8.33E-05	1.26E-05
4,4’-DDT	2.20E-03	2.20E-04	7.00E+00	1.19E-03	1.30E-03	7.40E-04	8.33E-05	1.25E-05
Aldrin	5.00E-04	3.00E+00	1.00E-01	2.00E-03	1.30E-03	8.30E-04	8.33E-05	1.49E-05
alpha-BHC	4.90E-02	1.00E-02	2.70E-01	6.00E-03	1.30E-03	6.60E-04	8.33E-05	1.36E-05
alpha-Chlordane	8.10E-04	2.20E-03	6.50E+00	<0.00003	1.30E-03	9.80E-04	8.33E-05	1.65E-05
beta-BHC	1.70E-01	1.00E-02	9.60E-01	5.00E-03	1.30E-03	1.00E-03	8.33E-05	2.16E-05
delta-BHC	4.90E-02	1.41E+02	2.70E-01	1.00E-02	1.30E-03	3.80E-04	8.33E-05	1.28E-05
Dieldrin	5.40E-04	5.60E-02	1.10E-01	1.90E-03	1.30E-03	8.20E-04	8.33E-05	1.39E-05
Endosulfan I	8.90E+02	5.60E-02	3.70E+02	2.90E-03	1.30E-03	9.40E-04	8.33E-05	1.57E-05
Endosulfan II	8.90E+02	5.60E-02	3.70E+02	1.40E-02	1.30E-03	9.80E-04	8.33E-05	1.47E-05
Endosulfan Sulfate	8.90E+02	5.60E-02	3.70E+02	5.40E-03	1.30E-03	5.70E-04	8.33E-05	8.70E-06
Endrin	6.00E-01	3.60E-02	1.80E+01	2.22E-03	1.30E-03	9.60E-04	8.33E-05	1.62E-05
Endrin Aldehyde	3.00E+00	3.00E-01	1.80E+01	2.22E-03	1.30E-03	9.00E-04	8.33E-05	1.62E-05
Endrin Ketone	6.00E-01	3.60E-02	1.80E+01	2.22E-03	1.30E-03	9.20E-04	8.33E-05	1.30E-05
gamma-BHC (Lindane)	1.80E+01	1.00E-02	2.10E+00	2.37E-03	1.30E-03	8.00E-04	8.33E-05	1.46E-05
gamma-Chlordane	8.10E-03	2.20E-03	6.50E+00	<0.00003	1.30E-03	9.60E-04	8.33E-05	1.64E-05
Heptachlor	7.90E-04	7.90E-05	3.80E-01	1.00E-02	1.30E-03	9.90E-04	8.33E-05	1.85E-05
Heptachlor Epoxide	3.90E-04	3.90E-05	1.90E-01	6.00E-04	1.30E-03	9.70E-04	8.33E-05	1.62E-05
Methoxychlor	NV	3.00E-02	3.10E+02	1.87E-02	2.50E-03	9.10E-04	1.67E-04	1.74E-05
Toxaphene	2.80E-03	2.80E-04	1.60E+00	1.00E-04	1.00E-01	1.86E-02	3.33E-03	5.56E-04
PCB – Aroclors by SW-846 8082A[3]								
Aroclor -1016	6.40E-04	6.40E-05	3.70E+00	2.60E-02	1.00E-02	2.52E-03	8.33E-01	1.24E-01
Aroclor -1221	6.40E-04	6.40E-05	5.40E-01	2.60E-02	1.00E-02	2.49E-03	8.33E-01	1.59E-01
Aroclor -1232	6.40E-04	6.40E-05	5.40E-01	2.60E-02	1.00E-02	2.93E-03	8.33E-01	1.43E-01
Aroclor -1242	6.40E-04	6.40E-05	7.40E-01	2.60E-02	1.00E-02	1.86E-03	8.33E-01	1.36E-01
Aroclor -1248	6.40E-04	6.40E-05	7.40E-01	2.60E-02	1.00E-02	2.27E-03	8.33E-01	7.88E-02
Aroclor -1254	6.40E-04	6.40E-05	7.40E-01	6.00E-02	1.00E-02	2.29E-03	8.33E-01	1.19E-01
Aroclor -1260	6.40E-04	6.40E-05	7.40E-01	2.60E-02	1.00E-02	1.36E-03	8.33E-01	1.18E-01

Table 2. Analyte lists and reporting limits for soil and groundwater (all parameters except PCB – congeners and PCDDs/PCDFs).

	Project Screening Limits[1]				Laboratory Limits[2]			
	Water (ug/L)		Solids (mg/Kg)		Water (ug/L)		Solids (mg/Kg)	
Parameter	**GW**	**SW**	**SO**	**SE**	**RL**	**MDL**	**RL**	**MDL**
Aroclor -1262	6.40E-04	6.40E-05	7.40E-01	2.60E-02	1.00E-02	1.36E-03	8.33E-01	1.18E-01
Aroclor -1268	6.40E-04	6.40E-05	7.40E-01	2.60E-02	1.00E-02	1.36E-03	8.33E-01	1.18E-01
GRO by SW-846 8015B								
Gasoline Range Organics (C6-C10)	NV	NV	NV	NV	100	TBD	0.05	TBD
DRO and ORO by SW-846 8015B								
Diesel Range Organics (C10-C28)	NV	NV	NV	NV	100	TBD	40	TBD
Oil Range Organics (C28-C36)	NV	NV	NV	NV	100	TBD	40	TBD
Metals by SW-846 6020A, 6010C, 7471B , and 7470A								
Aluminum	NV	8.70E+01	9.90E+04	NV	2.00E+02	9.68E+00	2.00E+01	1.08E+00
Antimony	6.40E+03	6.40E+02	4.10E+01	2.00E+00	2.00E+00	1.87E-02	2.00E-01	2.60E-03
Arsenic	1.40E+00	1.40E-01	1.60E+00	5.90E+00	1.00E+00	2.91E-01	1.00E-01	1.81E-02
Barium	NV	4.00E+00	1.90E+04	7.00E-01	1.00E+01	9.80E-02	1.00E+00	1.07E-02
Beryllium	NV	6.60E-01	2.00E+02	NV	1.00E+00	3.67E-02	1.00E-01	7.50E-03
Cadmium	NV	8.35E-01	8.00E+01	5.83E-01	1.00E+00	1.14E-01	1.00E-01	7.00E-03
Calcium	NV	1.16E+05	NV	NV	5.00E+03	9.68E+00	5.00E+02	9.82E-01
Chromium	NV	8.50E+01	5.60E+00	2.60E+01	2.00E+00	5.43E-01	2.00E-01	6.10E-03
Cobalt	NV	2.30E+01	3.00E+01	5.00E+01	5.00E-01	2.63E-02	5.00E-02	1.50E-03
Copper	NV	2.03E+01	4.10E+03	3.16E+01	2.50E+01	2.71E+00	2.50E+00	3.42E-01
Iron	NV	1.00E+03	7.20E+04	2.00E+04	1.00E+02	1.19E+01	1.00E+01	2.98E+00
Lead	NV	3.60E+00	8.00E+01	3.10E+01	1.00E+00	1.92E-02	1.00E-01	3.80E-03
Magnesium	NV	8.20E+04	NV	NV	5.00E+03	2.07E+01	5.00E+02	2.21E+00
Manganese	1.00E+03	1.20E+02	2.30E+03	4.60E+02	1.50E+01	6.80E-01	1.50E+00	4.80E-02
Mercury	NV	7.70E-01	4.30E+00	1.74E-01	2.00E-01	3.84E-02	3.30E-02	1.09E-02
Nickel	4.60E+04	7.28E+01	2.00E+03	1.60E+01	1.00E+00	1.75E-01	1.00E-01	1.13E-02
Potassium	NV	5.30E+04	NV	NV	5.00E+03	7.50E+02	5.00E+02	7.50E+01
Selenium	4.20E+04	5.00E+00	5.10E+02	NV	5.00E+00	4.22E-01	5.00E-01	5.02E-02
Silver	NV	3.20E+00	5.10E+02	5.00E-01	1.00E+00	3.62E-02	1.00E-01	3.90E-03
Sodium	NV	6.80E+05	NV	NV	5.00E+03	2.15E+02	5.00E+02	8.21E+00
Thallium	4.70E+00	4.70E-01	1.00E+00	NV	1.00E+00	1.52E-02	1.00E-01	2.00E-03
Vanadium	NV	2.00E+01	5.20E+02	NV	1.00E+00	8.24E-02	1.00E-01	7.90E-03
Zinc	2.60E+05	1.67E+02	3.10E+04	9.80E+01	2.00E+01	2.46E+00	2.00E+00	2.23E-01

Notes:

1. Project Screening Limits derived the following sources by matrix:
   Groundwater screening levels are derived from USEPA National Recommended Water Quality Criteria for Human Health (USEPA, 2009). Values for protection of water and organisms, and organisms only with a default dilution attenuation factor of 10. Screening limits based on groundwater discharge to surface water are used rather than

drinking water standards and criteria (e.g., MCLs, tap water RSLs), because groundwater at the site is not used for drinking water.
Surface Water (SW) = lowest of DDOE WQS Criteria, USEPA Region 3 Surface Water Criteria, and literature based benchmarks (Suter & Tsao 1996 and Buchman 2008)
Soils (SO) = USEPA Regional Screening Levels (RSLs). Industrial Soil. May 2010
Sediment (SE) = lowest of the NOAA SQuiRTS, USEPA Region 3 BTAG Freshwater Sediment Screening Benchmarks, USEPA Region 5 Ecological Screening Levels, or Ontario Ministry of the Environment Provincial Sediment Quality Guidelines
NOTE: Project Screening Limits are risk based and may not be achievable using EPA method laboratory techniques.

2 Adjustments for sample moisture and dilutions may elevate sample specific limits. Note all limits are subject to change based on final laboratory selection and required annual laboratory detection limit updates.

3 Pepco proposes a tiered approach on the PCB analysis, using EPA Method 8082A for PCBs as Aroclors as the first tier. If PCBs are detected by method 8082, then the first tier analysis will be sufficient. If PCBs are routinely not detected above the project screening levels, then alternate methods such as EPA 680 using GC/LRMS will be considered for water samples. Based on Pepco/AECOM’s discussions with different labs, a nominal per homolog Reporting Limit of 0.5 ng/L (which is below Pepco/AECOM’s 0.64 ng/L screening level) can be achieved. If the analyses warrant the use of Method 680, AECOM will submit additional SOPs to address this analytical method.

NV No value available NA Not applicable

Table 3. Analyte lists and detection limits for HRMS and isotope dilution methods.

Parameter		Project Screening Limit[1]				Estimated Minimum Level/ Estimated Detection Limit*			
		Water (pg/L)		Solids (pg/g)		Water (pg/L)		Solids (pg/g)	
		GW	SW	SO	SE	EML	EDL	EML	EDL
CB Name	**IUPAC Number**								
PCB – Congeners by EPA Method 1668C									
2-MoCB	1	640	NV	740000	2.5	40	0.6	5	0.2
3-MoCB	2	640	NV	740000	2.5	40	0.64	5	0.23
4-MoCB	3	640	NV	740000	2.5	40	0.7	5	0.27
2,2'-DiCB	4	640	NV	740000	2.5	40	3.8	5	1.54
2,3-DiCB	5	640	NV	740000	2.5	40	2.9	5	1.26
2,3'-DiCB	6	640	NV	740000	2.5	40	2.68	5	1.19
2,4-DiCB	7	640	NV	740000	2.5	40	2.76	5	1.22
2,4'-DiCB3	8	640	NV	740000	2.5	40	2.6	5	1.16
2,5-DiCB	9	640	NV	740000	2.5	40	2.76	5	1.23
2,6-DiCB	10	640	NV	740000	2.5	40	2.98	5	1.32
3,3'-DiCB	11	640	NV	740000	2.5	40	2.64	5	1.17
3,4-DiCB	12	640	NV	740000	2.5	40	2.7	5	1.2
3,4'-DiCB	13	640	NV	740000	2.5	40	2.7	5	1.2
3,5-DiCB	14	640	NV	740000	2.5	40	2.34	5	1.03
4,4'-DiCB	15	640	NV	740000	2.5	40	2.76	5	1.31
2,2',3-TrCB	16	640	NV	740000	2.5	40	2.58	5	1.03
2,2',4-TrCB	17	640	NV	740000	2.5	40	2.16	5	0.86
2,2',5-TrCB3	18	640	NV	740000	2.5	40	1.88	5	0.75
2,2',6-TrCB	19	640	NV	740000	2.5	40	2.64	5	1.06
2,3,3'-TrCB	20	640	NV	740000	2.5	40	0.9	5	0.47
2,3,4-TrCB	21	640	NV	740000	2.5	40	0.9	5	0.47
2,3,4'-TrCB	22	640	NV	740000	2.5	40	0.92	5	0.48
2,3,5-TrCB	23	640	NV	740000	2.5	40	0.94	5	TBD
2,3,6-TrCB	24	640	NV	740000	2.5	40	1.8	5	0.72
2,3',4-TrCB	25	640	NV	740000	2.5	40	0.84	10	0.43
2,3',5-TrCB	26	640	NV	740000	2.5	40	0.88	10	0.46
2,3',6-TrCB	27	640	NV	740000	2.5	40	1.56	10	0.62
2,4,4'-TrCB3	28	640	NV	740000	2.5	40	0.9	10	0.47
2,4,5-TrCB	29	640	NV	740000	2.5	40	0.88	10	0.46
2,4,6-TrCB	30	640	NV	740000	2.5	40	1.92	10	0.76
2,4',5-TrCB	31	640	NV	740000	2.5	40	0.88	10	0.46
2,4',6-TrCB	32	640	NV	740000	2.5	40	1.52	10	0.61
2',3,4-TrCB	33	640	NV	740000	2.5	40	0.9	10	0.47
2',3,5-TrCB	34	640	NV	740000	2.5	40	0.92	10	0.48
3,3',4-TrCB	35	640	NV	740000	2.5	40	0.94	10	0.49

Table 3. Analyte lists and detection limits for HRMS and isotope dilution methods.

Parameter		Project Screening Limit[1]				Estimated Minimum Level/ Estimated Detection Limit*			
		Water (pg/L)		Solids (pg/g)		Water (pg/L)		Solids (pg/g)	
		GW	SW	SO	SE	EML	EDL	EML	EDL
3,3',5-TrCB	36	640	NV	740000	2.5	40	0.92	10	0.48
3,4,4'-TrCB	37	640	NV	740000	2.5	40	0.94	10	0.49
3,4,5-TrCB	38	640	NV	740000	2.5	40	0.96	10	0.5
3,4',5-TrCB	39	640	NV	740000	2.5	40	0.86	10	0.45
2,2',3,3'-TeCB	40	640	NV	740000	2.5	40	1.42	10	0.73
2,2',3,4-TeCB	41	640	NV	740000	2.5	40	1.42	10	0.73
2,2',3,4'-TeCB	42	640	NV	740000	2.5	40	1.44	10	0.74
2,2',3,5-TeCB	43	640	NV	740000	2.5	40	1.32	10	0.68
2,2',3,5'-TeCB3	44	640	NV	740000	2.5	40	1.26	10	0.64
2,2',3,6-TeCB	45	640	NV	740000	2.5	40	1.48	10	0.75
2,2',3,6'-TeCB	46	640	NV	740000	2.5	40	1.74	10	0.89
2,2',4,4'-TeCB	47	640	NV	740000	2.5	40	1.28	10	0.65
2,2',4,5-TeCB	48	640	NV	740000	2.5	40	1.4	10	0.72
2,2',4,5'-TeCB	49	640	NV	740000	2.5	40	1.18	10	0.6
2,2',4,6-TeCB	50	640	NV	740000	2.5	40	1.36	10	0.7
2,2',4,6'-TeCB	51	640	NV	740000	2.5	40	1.48	10	0.75
2,2',5,5'-TeCB3	52	640	NV	740000	2.5	40	1.36	10	0.69
2,2',5,6'-TeCB	53	640	NV	740000	2.5	40	1.36	10	0.7
2,2',6,6'-TeCB	54	640	NV	740000	2.5	40	2.06	10	0.85
2,3,3',4'-TeCB	55	640	NV	740000	2.5	40	1.1	10	0.56
2,3,3',4'-TeCB	56	640	NV	740000	2.5	40	1.04	10	0.53
2,3,3',5-TeCB	57	640	NV	740000	2.5	40	1.04	10	0.54
2,3,3',5'-TeCB	58	640	NV	740000	2.5	40	1.04	10	0.53
2,3,3',6-TeCB	59	640	NV	740000	2.5	40	1.02	10	0.52
2,3,4,4'-TeCB	60	640	NV	740000	2.5	40	1.06	10	0.55
2,3,4,5-TeCB	61	640	NV	740000	2.5	40	1.02	10	0.52
2,3,4,6-TeCB	62	640	NV	740000	2.5	40	1.02	10	0.52
2,3,4',5-TeCB	63	640	NV	740000	2.5	10	0.98	10	0.5
2,3,4',6-TeCB	64	640	NV	740000	2.5	40	0.96	10	0.49
2,3,5,6-TeCB	65	640	NV	740000	2.5	40	1.28	10	0.65
2,3',4,4'-TeCB3	66	640	NV	740000	2.5	40	1.0	10	0.51
2,3',4,5-TeCB	67	640	NV	740000	2.5	40	0.94	10	0.48
2,3',4,5'-TeCB	68	640	NV	740000	2.5	40	0.94	10	0.49
2,3',4,6-TeCB	69	640	NV	740000	2.5	40	1.18	10	0.6
2,3',4',5-TeCB	70	640	NV	740000	2.5	40	1.02	10	0.52
2,3',4',6-TeCB	71	640	NV	740000	2.5	40	1.42	10	0.73
2,3',5,5'-TeCB	72	640	NV	740000	2.5	40	1.02	10	0.52
2,3',5',6-TeCB	73	640	NV	740000	2.5	40	1.32	10	0.68

Table 3. Analyte lists and detection limits for HRMS and isotope dilution methods.

Parameter		Project Screening Limit[1]				Estimated Minimum Level/ Estimated Detection Limit*			
		Water (pg/L)		Solids (pg/g)		Water (pg/L)		Solids (pg/g)	
		GW	SW	SO	SE	EML	EDL	EML	EDL
2,4,4',5-TeCB	74	640	NV	740000	2.5	40	1.02	10	0.52
2,4,4',6-TeCB	75	640	NV	740000	2.5	40	1.02	10	0.52
2',3,4,5-TeCB	76	640	NV	740000	2.5	40	1.02	10	0.52
3,3',4,4'-TeCB3,6 DL	77	640	NV	110000	2.5	40	0.96	10	0.5
3,3',4,5-TeCB	78	640	NV	740000	2.5	40	1.08	10	0.55
3,3',4,5'-TeCB	79	640	NV	740000	2.5	40	0.96	10	0.49
3,3',5,5'-TeCB	80	640	NV	740000	2.5	40	0.92	10	0.47
3,4,4',5-TeCB6 DL	81	640	NV	38000	2.5	40	0.98	10	0.49
2,2',3,3',4-PeCB	82	640	NV	740000	2.5	40	2.12	10	0.89
2,2',3,3',5-PeCB	83	640	NV	740000	2.5	40	1.78	10	0.75
2,2',3,3',6-PeCB	84	640	NV	740000	2.5	40	2.04	10	0.85
2,2',3,4,4'-PeCB	85	640	NV	740000	2.5	40	1.48	10	0.61
2,2',3,4,5-PeCB	86	640	NV	740000	2.5	40	1.5	10	0.63
2,2',3,4,5'-PeCB	87	640	NV	740000	2.5	40	1.5	10	0.63
2,2',3,4,6-PeCB	88	640	NV	740000	2.5	40	1.82	10	0.76
2,2',3,4,6'-PeCB	89	640	NV	740000	2.5	40	1.96	10	0.82
2,2',3,4',5-PeCB	90	640	NV	740000	2.5	40	1.54	10	0.63
2,2',3,4',6-PeCB	91	640	NV	740000	2.5	40	1.82	10	0.76
2,2',3,5,5'-PeCB	92	640	NV	740000	2.5	40	1.74	10	0.73
2,2',3,5,6-PeCB	93	640	NV	740000	2.5	40	1.74	10	0.73
2,2',3,5,6'-PeCB	94	640	NV	740000	2.5	40	1.96	10	0.82
2,2',3,5',6-PeCB	95	640	NV	740000	2.5	40	1.86	10	0.77
2,2',3,6,6'-PeCB	96	640	NV	740000	2.5	40	1.48	10	0.61
2,2',3',4,5-PeCB	97	640	NV	740000	2.5	40	1.5	10	0.63
2,2',3',4,6-PeCB	98	640	NV	740000	2.5	40	1.7	10	0.71
2,2',4,4',5-PeCB	99	640	NV	740000	2.5	40	1.78	10	0.75
2,2',4,4',6-PeCB	100	640	NV	740000	2.5	40	1.74	10	0.73
2,2',4,5,5'-PeCB3	101	640	NV	740000	2.5	40	1.52	10	0.63
2,2',4,5,6'-PeCB	102	640	NV	740000	2.5	10	1.7	10	0.71
2,2',4,5,'6-PeCB	103	640	NV	740000	2.5	40	1.72	10	0.72
2,2',4,6,6'-PeCB	104	640	NV	740000	2.5	40	1.32	10	0.55
2,3,3',4,4'-PeCB3,6 DL	105	640	NV	380000	1500	40	0.88	10	0.42
2,3,3',4,5-PeCB	106	640	NV	740000	2.5	40	0.94	10	0.46
2,3,3',4',5-PeCB	107	640	NV	740000	2.5	40	0.92	10	0.45
2,3,3',4,5'-PeCB	108	640	NV	740000	2.5	40	0.96	10	0.47
5/2,3,3',4,6-PeCB	109	640	NV	740000	2.5	40	1.5	10	0.63
2,3,3',4',6-PeCB	110	640	NV	740000	2.5	40	1.3	10	0.54
2,3,3',5,5'-PeCB	111	640	NV	740000	2.5	40	1.24	10	0.51

Table 3. Analyte lists and detection limits for HRMS and isotope dilution methods.

Parameter		Project Screening Limit[1]				Estimated Minimum Level/ Estimated Detection Limit*			
		Water (pg/L)		Solids (pg/g)		Water (pg/L)		Solids (pg/g)	
		GW	SW	SO	SE	EML	EDL	EML	EDL
2,3,3',5,6-PeCB	112	640	NV	740000	2.5	40	1.34	10	0.56
2,3,3',5',6-PeCB	113	640	NV	740000	2.5	40	1.54	10	0.63
2,3,4,4',5-PeCB6 DL	114	640	NV	380000	2.5	40	0.88	10	0.41
2,3,4,4',6-PeCB	115	640	NV	740000	2.5	40	1.3	10	0.54
2,3,4,5,6-PeCB	116	640	NV	740000	2.5	40	1.48	10	0.61
2,3,4',5,6-PeCB	117	640	NV	740000	2.5	40	1.48	10	0.61
2,3',4,4',5-PeCB3,6 DL	118	640	NV	380000	2.5	40	0.88	10	0.42
2,3',4,4',6-PeCB	119	640	NV	740000	2.5	40	1.5	10	0.63
2,3',4,5,5'-PeCB	120	640	NV	740000	2.5	40	1.26	10	0.53
2,3',4,5,'6-PeCB	121	640	NV	740000	2.5	40	1.28	10	0.53
2',3,3',4,5-PeCB	122	640	NV	740000	2.5	40	1.04	10	0.5
2',3,4,4',5-PeCB6 DL	123	640	NV	380000	2.5	40	1.02	10	0.45
2',3,4,5,5'-PeCB	124	640	NV	740000	2.5	40	0.96	10	0.47
2',3,4,5,6'-PeCB	125	640	NV	740000	2.5	40	1.5	10	0.63
3,3',4,4',5-PeCB3,6 DL	126	640	NV	110	2.5	40	0.92	10	/0.47
3,3',4,5,5'-PeCB	127	640	NV	740000	2.5	40	0.94	10	0.45
2,2',3,3',4,4'-HxCB3	128	640	NV	740000	2.5	40	1.4	10	0.69
2,2',3,3',4,5-HxCB	129	640	NV	740000	2.5	40	1.46	10	0.72
2,2',3,3',4,5'-HxCB	130	640	NV	740000	2.5	40	1.88	10	0.93
2,2',3,3',4,6-HxCB	131	640	NV	740000	2.5	40	1.92	10	0.96
2,2',3,3',4,6'-HxCB	132	640	NV	740000	2.5	40	1.38	10	0.91
2,2',3,3',5,5'-HxCB	133	640	NV	740000	2.5	40	1.76	10	0.88
2,2',3,3',5,6-HxCB	134	640	NV	740000	2.5	40	1.88	10	0.94
2,2',3,3',5,6'-HxCB	135	640	NV	740000	2.5	40	2.44	10	1.02
2,2',3,3',6,6'-HxCB	136	640	NV	740000	2.5	40	1.8	10	0.75
2,2',3,4,4',5-HxCB	137	640	NV	740000	2.5	40	1.62	10	0.81
2,2',3,4,4',5'-HxCB3	138	640	NV	740000	2.5	40	1.44	10	0.71
2,2',3,4,4',6-HxCB	139	640	NV	740000	2.5	40	1.6	10	0.8
2,2',3,4,4',6'-HxCB	140	640	NV	740000	2.5	40	1.6	10	0.8
2,2',3,4,5,5'-HxCB	141	640	NV	740000	2.5	40	1.68	10	0.83
2,2',3,4,5,6-HxCB	142	640	NV	740000	2.5	40	1.84	10	0.92
2,2',3,4,5,6'-HxCB	143	640	NV	740000	2.5	40	1.88	10	0.94
2,2',3,4,5',6-HxCB	144	640	NV	740000	2.5	40	2.26	10	0.95
2,2',3,4,6,6'-HxCB	145	640	NV	740000	2.5	40	1.72	10	0.72
2,2',3,4',5,5'-HxCB	146	640	NV	740000	2.5	40	1.52	10	0.76
2,2',3,4',5,6-HxCB	147	640	NV	740000	2.5	40	1.56	10	0.78
2,2',3,4',5,6'-HxCB	148	640	NV	740000	2.5	40	2.4	10	1.01
2,2',3,4',5',6-HxCB	149	640	NV	740000	2.5	40	1.56	10	0.78

Table 3. Analyte lists and detection limits for HRMS and isotope dilution methods.

		Project Screening Limit[1]				Estimated Minimum Level/ Estimated Detection Limit*			
		Water (pg/L)		Solids (pg/g)		Water (pg/L)		Solids (pg/g)	
Parameter		**GW**	**SW**	**SO**	**SE**	**EML**	**EDL**	**EML**	**EDL**
2,2',3,4',6,6'-HxCB	150	640	NV	740000	2.5	40	1.68	10	0.7
2,2',3,5,5',6-HxCB	151	640	NV	740000	2.5	40	2.44	10	1.02
2,2',3,5,6,6'-HxCB	152	640	NV	740000	2.5	40	1.7	10	0.71
2,2',4,4',5,5'-HxCB3	153	640	NV	740000	2.5	40	1.24	10	0.62
2,2',4,4',5',6-HxCB	154	640	NV	740000	2.5	40	1.98	10	0.83
2,2',4,4',6,6'-HxCB	155	640	NV	740000	2.5	40	1.62	10	0.68
2,3,3',4,4',5-HxCB6 DL	156	640	NV	380000	2.5	40	1.38	10	0.69
2,3,3',4,4',5'-HxCB6 DL	157	640	NV	380000	2.5	40	1.38	10	0.69
2,3,3',4,4',6-HxCB	158	640	NV	740000	2.5	40	1.14	10	0.57
2,3,3',4,5,5'-HxCB	159	640	NV	740000	2.5	40	1.22	10	0.61
2,3,3',4,5,6-HxCB	160	640	NV	740000	2.5	40	1.46	10	0.72
2,3,3',4,5',6-HxCB	161	640	NV	740000	2.5	40	1.22	10	0.61
2,3,3',4',5,5'-HxCB	162	640	NV	740000	2.5	40	1.22	10	0.6
2,3,3',4',5,6-HxCB	163	640	NV	740000	2.5	40	1.46	10	0.72
2,3,3',4',5',6-HxCB	164	640	NV	740000	2.5	40	1.28	10	0.64
2,3,3',5,5',6-HxCB	165	640	NV	740000	2.5	40	1.34	10	0.67
2,3,4,4',5,6-HxCB	166	640	NV	740000	2.5	40	1.4	10	0.7
2,3',4,4',5,5'-HxCB6 DL	167	640	NV	380000	2.5	40	0.92	10	0.45
2,3',4,4',5',6-HxCB	168	640	NV	740000	2.5	40	1.26	10	0.62
3,3',4,4',5,5'-HxCB3,6 DL	169	640	NV	380	2.5	40	1.1	10	0.55
2,2',3,3',4,4',5-HpCB3	170	640	NV	740000	2.5	40	1.54	10	0.77
2,2'3,3',4,4',6-HpCB	171	640	NV	740000	2.5	40	1.68	10	0.78
2,2',3,3',4,5,5'-HpCB	172	640	NV	740000	2.5	40	1.66	10	0.77
2,2',3,3',4,5,6-HpCB	173	640	NV	740000	2.5	40	1.68	10	0.78
2,2',3,3',4,5,6'-HpCB	174	640	NV	740000	2.5	40	1.56	10	0.72
2,2',3,3',4,5',6-HpCB	175	640	NV	740000	2.5	40	1.5	10	0.69
2,2',3,3',4,6,6'-HpCB	176	640	NV	740000	2.5	40	1.14	10	0.69
2,2',3,3',4',5,6-HpCB	177	640	NV	740000	2.5	40	1.6	10	0.74
2,2',3,3',5,5',6-HpCB	178	640	NV	740000	2.5	40	1.62	10	0.75
2,2',3,3',5,6,6'-HpCB	179	640	NV	740000	2.5	40	1.2	10	0.56
2,2',3,4,4',5,5'-HpCB3	180	640	NV	740000	2.5	40	1.62	10	0.57
2,2',3,4,4',5,6-HpCB	181	640	NV	740000	2.5	40	1.5	10	0.69
2,2',3,4,4',5,6'-HpCB	182	640	NV	740000	2.5	40	1.46	10	0.67
2,2',3,4,4',5',6-HpCB	183	640	NV	740000	2.5	40	1.48	10	0.69
2,2',3,4,4',6,6'-HpCB	184	640	NV	740000	2.5	40	1.24	10	0.57
2,2',3,4,5,5',6-HpCB	185	640	NV	740000	2.5	40	1.48	10	0.69
2,2',3,4,5,6,6'-HpCB	186	640	NV	740000	2.5	40	1.2	10	0.55
2,2',3,4',5,5',6-HpCB3	187	640	NV	740000	2.5	40	1.38	10	0.63

Table 3. Analyte lists and detection limits for HRMS and isotope dilution methods.

		Project Screening Limit[1]				Estimated Minimum Level/ Estimated Detection Limit*			
		Water (pg/L)		Solids (pg/g)		Water (pg/L)		Solids (pg/g)	
Parameter		GW	SW	SO	SE	EML	EDL	EML	EDL
2,2',3,4',5,6,6'-HpCB	188	640	NV	740000	2.5	40	1.16	10	0.51
2,3,3',4,4',5,5'-HpCB6 DL	189	640	NV	380000	2.5	40	0.84	10	0.43
2,3,3',4,4',5,6-HpCB	190	640	NV	740000	2.5	40	1.16	10	0.54
2,3,3',4,4',5',6-HpCB	191	640	NV	740000	2.5	40	1.14	10	0.53
2,3,3',4,5,5',6-HpCB	192	640	NV	740000	2.5	40	1.28	10	0.59
2,3,3',4',5,5',6-HpCB	193	640	NV	740000	2.5	40	1.26	10	0.58
2,2',3,3',4,4',5,5'-OcCB	194	640	NV	740000	2.5	40	1.14	10	0.62
2,2',3,3',4,4',5,6-OcCB3	195	640	NV	740000	2.5	40	1.22	10	0.66
2,2',3,3',4,4',5,6'-OcCB	196	640	NV	740000	2.5	40	1.22	10	0.82
2,2',3,3',4,4',6,6'-OcCB	197	640	NV	740000	2.5	40	1.24	10	0.61
2,2',3,3',4,5,5',6-OcCB	198	640	NV	740000	2.5	40	1.72	10	0.85
2,2',3,3',4,5,5',6'-OcCB	199	640	NV	740000	2.5	40	1.22	10	0.6
2,2',3,3',4,5,6,6'-OcCB	200	640	NV	740000	2.5	40	1.18	10	0.58
2,2',3,3',4,5',6,6'-OcCB	201	640	NV	740000	2.5	40	1.72	10	0.85
2,2',3,3',5,5',6,6'-OcCB	202	640	NV	740000	2.5	40	1.32	10	0.66
2,2',3,4,4',5,5',6-OcCB	203	640	NV	740000	2.5	40	1.54	10	0.76
2,2',3,4,4',5,6,6'-OcCB	204	640	NV	740000	2.5	40	1.3	10	0.64
2,3,3',4,4',5,5',6-OcCB	205	640	NV	740000	2.5	40	0.96	10	0.53
2,2',3,3',4,4',5,5',6-NoCB3	206	640	NV	740000	2.5	40	1.7	10	0.91
2,2',3,3',4,4',5,6,6'-NoCB	207	640	NV	740000	2.5	40	1.2	10	0.64
2,2',3,3',4,5,5',6,6'-NoCB	208	640	NV	740000	2.5	40	1.24	10	0.66
DeCB3	209	640	NV	740000	2.5	40	1.64	10	0.66

Table 4. Analyte lists and detection limits for HRMS and isotope dilution methods.

Parameter	CAS Number	Project Screening Limit[1]				Lower Calibration Level/ Estimated Detection Limit*			
		Water (pg/L)		Solids (pg/g)		Water (pg/L)		Solids (pg/g)	
		GW	SW	SO	SE	EML	EDL	EML	EDL
PCDD/PCDFs –by EPA Method 8290A									
1,2,3,4,6,7,8-HPCDD	35822-46-9	NV	NV	NV	NA	50	1.6	5	0.18
1,2,3,4,6,7,8-HPCDF	67562-39-4	NV	NV	NV	NA	50	1.1	5	0.11
1,2,3,4,7,8-HxCDD	39227-28-6	NV	NV	NV	NA	50	1.6	5	0.17
1,2,3,4,7,8-HXCDF	70648-26-9	NV	NV	NV	NA	50	1.4	5	0.13
1,2,3,4,7,8,9-HPCDF	55673-89-7	NV	NV	NV	NA	50	0.82	5	0.078
1,2,3,6,7,8-HxCDD	57653-85-7	NV	NV	NV	NA	50	1.5	5	0.16
1,2,3,6,7,8-HXCDF	57117-44-9	NV	NV	NV	NA	50	0.83	5	0.077
1,2,3,7,8,9-HxCDD	19408-74-3	NV	NV	NV	NA	50	1.3	5	0.12
1,2,3,7,8,9-HXCDF	72918-21-9	NV	NV	NV	NA	50	1.1	5	0.12
1,2,3,7,8-PeCDD	40321-76-4	NV	NV	NV	NA	50	1.8	5	0.17
1,2,3,7,8-PECDF	57117-41-6	NV	NV	NV	NA	50	1.4	5	0.12
2,3,4,6,7,8-HXCDF	60851-34-5	NV	NV	NV	NA	50	0.86	5	0.084
2,3,4,7,8-PECDF	57117-31-4	NV	NV	NV	NA	50	1.2	5	0.11
2,3,7,8-TCDD	1746-01-6	5.10E-08	0.00001	18	0.85	10	3.5	1	0.31
2,3,7,8-TCDF	51207-31-9	NV	NV	NV	NA	10	2.3	1	0.20
OCDD	3268-87-9	NV	NV	NV	NA	100	1.7	10	0.20
OCDF	39001-02-0	NV	NV	NV	NA	100	1.9	10	0.21
Total HpCDF	3898-75-3	NV	NV	NV	NA	NA	NA	NA	NA
Total HpCDD	37871-00-4	NV	NV	NV	NA	NA	NA	NA	NA
Total HxCDF	55684-94-1	NV	NV	NV	NA	NA	NA	NA	NA
Total HxCDD	34465-46-8	NV	NV	NV	NA	NA	NA	NA	NA
Total PeCDF	60402-15-4	NV	NV	NV	NA	NA	NA	NA	NA
Total PeCDD	36088-22-9	NV	NV	NV	NA	NA	NA	NA	NA
Total TCDF	55722-27-5	NV	NV	NV	NA	NA	NA	NA	NA

Table 5. Analyte lists and detection limits for HRMS and isotope dilution methods.

Parameter	CAS Number	Project Screening Limit[1]				Lower Calibration Level/ Method Detection Limit*			
		Water (ug/L)		Solids (mg/kg)		Water (ng/L)		Solids (ng/g)	
		GW	SW	SO	SE	QL	MDL	QL	MDL
PAHs and alkylated PAH homologs –by Method ID0016									
Acenaphthene	83-32-9	9.90E+03	5.00E+01	3.30E+03	6.71E-03	10	2.4	1	0.21
Acenaphthylene	208-96-8	9.90E+03	4.84E+03	3.30E+03	5.87E-03	10	0.15	1	0.063
Anthracene	120-12-7	4.00E+05	4.00E+04	1.70E+04	1.00E-02	10	0.71	1	0.19
Benzo(a)anthracene	56-55-3	1.80E-01	1.80E-02	2.10E-01	3.19E-02	10	1.5	1	0.29
Benzo(b)fluoranthene	205-99-2	1.80E-01	1.80E-02	2.10E+00	1.04E+01	10	1.5	1	0.25
Benzo(k)fluoranthene	207-08-9	1.80E-01	NV	2.10E+01	2.72E-02	10	1	1	0.22
Benzo(ghi)perylene	191-24-2	4.00E+04	7.64E+00	1.70E+03	1.70E-01	10	0.51	1	0.15
Benzo(a)pyrene	50-32-8	1.80E-01	2.10E+00	1.57E-02	2.00E-01	10	0.4	1	0.19
Benzo(e)pyrene	192-97-2	NV	NV	NV	NV	10	1.4	1	0.17
Chrysene	218-01-9	1.80E-01	1.80E-02	2.10E+02	2.68E-02	10	0.22	1	0.2
C1-Chrysenes/benz(a)anthracenes	NV	NV	NV	NV	NV	10	10	1	1
C2-Chrysenes/benz(a)anthracenes	NV	NV	NV	NV	NV	10	10	1	1
C3-Chrysenes/benz(a)anthracenes	NV	NV	NV	NV	NV	10	10	1	1
C4-Chrysenes/benz(a)anthracenes	NV	NV	NV	NV	NV	10	10	1	1
Dibenz(a,h)anthracene	53-70-3	1.80E-01	1.80E-02	2.10E-01	6.22E-03	10	0.78	1	0.07
Dibenzothiophene	132-65-0	NV	NV	NV	NV	10	0.69	1	0.14
C1-Dibenzothiophenes	NA	NV	NV	NV	NV	10	10	1	1
C2-Dibenzothiophenes	NA	NV	NV	NV	NV	10	10	1	1
C3-Dibenzothiophenes	NA	NV	NV	NV	NV	10	10	1	1
C4-Dibenzothiophenes	NA	NV	NV	NV	NV	10	10	1	1
2,6-Dimethylnaphthalene	581-42-0	NV	NV	NV	NV	10	2.2	2	0.44
Fluoranthene	206-44-0	1.40E+03	1.40E+02	2.20E+03	3.15E-02	10	2.4	1	0.36
C1-Fluoranthenes/pyrenes	NA	NV	NV	NV	NV	10	10	1	1
Fluorene	86-73-7	5.30E+04	5.30E+03	2.20E+03	1.00E-02	10	1.5	1	0.47
C1-Fluorenes	NA	NV	NV	NV	NV	10	10	1	1
C2-Fluorenes	NA	NV	NV	NV	NV	10	10	1	1
C3-Fluorenes	NA	NV	NV	NV	NV	10	10	1	1
Indeno(1,2,3-cd)pyrene	193-39-5	1.80E-01	4.31E+00	2.10E+00	1.73E-02	10	1	1	0.17
2-Methylnaphthalene	91-57-6	NA	4.70E+00	2.20E+02	2.02E-02	20	8.3	10	2.9
1-Methylnaphthalene	90-12-0	NA	NV	NV	NV	10	4.1	5	1.3
Naphthalene	91-20-3	NV	6.00E+02	1.80E+01	1.47E-02	50	16	20	5.3
C2-Naphthalenes	NA	NV	NV	NV	NV	10	10	2	2
C3-Naphthalenes	NA	NV	NV	NV	NV	10	10	2	2
C4-Naphthalenes	NA	NV	NV	NV	NV	10	10	1	1
Perylene	198-55-0	NV	NV	NV	NV	10	0.81	1	0.12
Phenanthrene	85-01-8	4.00E+05	4.00E-01	1.70E+04	1.87E-02	20	11	2	1.6

Table 5. Analyte lists and detection limits for HRMS and isotope dilution methods.

Parameter	CAS Number	Project Screening Limit[1]				Lower Calibration Level/ Method Detection Limit*			
		Water (ug/L)		Solids (mg/kg)		Water (ng/L)		Solids (ng/g)	
		GW	SW	SO	SE	QL	MDL	QL	MDL
C1-Phenanthrenes/anthracenes	NA	NV	NV	NV	NV		10	1	1
C2-Phenanthrenes/anthracenes	NA	NV	NV	NV	NV	10	10	1	1
C3-Phenanthrenes/anthracenes	NA	NV	NV	NV	NV	10	10	1	1
C4-Phenanthrenes/anthracenes	NA	NV	NV	NV	NV	10	10	1	1
Pyrene	129-00-0	4.00E+04	2.50E-02	1.70E+03	4.43E-02	10	1.7	2	1.1
2,3,5-Trimethylnaphthalene	2245-38-7	NV	NV	NV	NV	10	1.6	2	0.46

Notes:

1. Project Screening Limits derived the following sources by matrix:
Groundwater (GW) = USEPA National Recommended Water Quality Criteria 2009 for human health (organisms only), default DAF of 10 applied.
Surface Water (SW) = lowest of DDOE WQS Criteria, USEPA Region 3 Surface Water Criteria, and literature based benchmarks (Suter & Tsao 1996 and Buchman 2008)
Soils (SO) = USEPA Regional Screening Levels (RSLs). Industrial Soil. May 2010
Sediment (SE) = lowest of the NOAA SQuiRTS, USEPA Region 3 BTAG Freshwater Sediment Screening Benchmarks, USEPA Region 5 Ecological Screening Levels, or Ontario Ministry of the Environment Provincial Sediment Quality Guidelines

NOTE: Project Screening Limits are risk based and may not be achievable using EPA method laboratory techniques.

*Average estimated detection limits for soil and water method blanks. Note all PCDD/PCDF and PCB congener results above the sample specific EDL will be reported and reporting detection limits will be based on the EDL, not the EML or QL. Adjustments for sample moisture and dilutions may elevate sample specific limits. Note all limits are subject to change based on final laboratory selection and required annual laboratory detection limit updates

NR Not reported

NV No Value

DL Dioxin-like

Table 6. Sample container, preservation, and holding time requirement.

Parameter	Container [1]	Preservation	Holding Time [2]
Solid Samples			
VOCs	High level analysis: 1- 40 mL vial filled with 5 mL methanol (5 g soil to 5 mL methanol) Low level analysis: 2-40 mL vials with teflon stir bar and filled with 5 mL deionized water (5 g soil to 5 mL deionized water) % solids: 1 - 60 mL plastic	Ice, 4^{0}C, in field	48 hours to freezing for water preserved samples; 14 days from collection to analysis for methanol and water preserved samples
SVOCs	1-8 oz amber glass with Teflon-lined cap	Ice, 4°C.	14 days to extraction; 40 days from extraction to analysis
PAHs	1-8 oz amber glass with Teflon-lined cap	Ice, 4°C. Maintain in dark; lab storage at <-10°C.	100 days to extraction; 40 days from extraction to analysis
Metals	1-8 oz amber glass with Teflon-lined cap	Ice, 4°C.	28 days to analysis (mercury); 180 days to analysis (other metals).
AVS/SEM	1-4 oz. amber glass with Teflon-lined cap	Ice, 4°C, no headspace	14 days to analysis
DRO/ORO	1-8 oz amber glass with Teflon-lined cap	Ice, 4°C.	14 days to extraction; 40 days from extraction to analysis
GRO	1-40 mL vial filled with 5 mL methanol (5 g soil in 5 mL methanol)	Ice, 4°C.	28 days
OCPs	1-8 oz amber glass with Teflon-lined cap	Ice, 4°C.	14 days to extraction; 40 days from extraction to analysis
PCBs as Aroclors	1-8 oz amber glass with Teflon-lined cap	Ice, 4°C.	14 days to extraction; 40 days from extraction to analysis
PCBs as Congeners	1-8 oz amber glass with Teflon-lined cap	Ice, 4°C. Maintain in dark; lab storage at <-10°C.	365 calendar days for preparation and analysis
PCDDs/PCDFs	1-8 oz amber glass with Teflon-lined cap	Ice, 4°C. Maintain in dark; ; lab storage at <-10°C.	365 calendar days for preparation and analysis

Table 6. Sample container, preservation, and holding time requirement.

Parameter	Container [1]	Preservation	Holding Time [2]
Aqueous Samples			
VOCs	3 x 40 mL vials	HCl to pH <2; Ice, 4°C.	14 days
SVOCs (incl. PAHs only)	2 x 1 L, amber glass	Ice, 4^{o}C	7 days to extraction; 40 days from extraction to analysis
Metals, total	500 mL, plastic	HNO_3 to pH <2 Ice, 4°C.	28 days to analysis (mercury); 180 days to analysis (other metals).
DRO	1 x 2 L, amber glass	HCl to pH <2; Ice, 4^{o}C	14 days to extraction; 40 days from extraction to analysis
GRO	2 x 40 mL vials	HCl to pH <2; Ice, 4°C.	14 days
PCBs -Aroclors	2 x 1 L, amber glass	Ice, 4^{o}C	7 days to extraction; 40 days from extraction to analysis
OCP	2 x 1 L, amber glass	Ice, 4^{o}C	7 days to extraction; 40 days from extraction to analysis
PCB - congeners	2 x 1 L, amber glass	Ice, 4^{o}C	365 calendar days for preparation and analysis
PCDDs/PCDFs	1-8 oz amber glass with Teflon-lined cap	Ice, 4°C. Maintain in dark	365 calendar days for preparation and analysis

[1] Laboratory may provide alternate containers as long as the containers meet the requirements of the method and allow the collection of sufficient volume to perform the analyses and any reanalyses required by the method.

[2] Holding time begins from date of sample collection.

Table 7. Preparation and Analytical methodologies

Parameter	Methodology
TCL VOCs	SW-846 5030B/5035A/8260B
TCL SVOCs	SW-846 8270C
TAL Metals	SW-846 6010C/6020A/7470A/7471B
TCL Pesticides (low level for aqueous samples)	SW-846 8081B
TCL PCBs - Aroclors	SW-846 8082A
PCB – Homologs (optional)	EPA 680 modified
DRO and ORO	SW-846 8015B
GRO	SW-846 8015B
AVS/SEM	EPA-821-R-91-100
PCB - congeners	EPA 1668
PCDD/PCDFs	SW-846 8290

Table 8. Laboratory Preparation and Analytical SOPs

Reference Number	Fixed or Mobile Laboratory Performing Analysis	Title	Analytical Parameter
PT-MS-002, Rev.17	TestAmerica - Pittsburgh	Volatile Compounds by GC/MS	VOCs
PT-MS-001, Rev.11	TestAmerica - Pittsburgh	Semivolatile Organic Analysis by GC/MS	SVOCs
PT-GC-006, Rev.3	TestAmerica - Pittsburgh	Chlorinated Pesticides	OCPs
LAM-005, Rev 3	ECCS Mobile Lab	Polychlorinated Biphenyl (PCB) as Arolcors by Gas Chromatography	PCB Aroclors
KNOX-ID-0013, Rev 11	TestAmerica – Knoxville	Analysis of Polychlorinated Biphenyl (PCB) Isomers by Isotope Dilution HRGC/HRMS	PCB Congeners
PT-MT-002, Rev. 8	TestAmerica - Pittsburgh	Analysis of Metals by Inductively Coupled Plasma/Mass Spectrometry (ICPMS)	Metals (aqueous, excl. mercury)
PT-MT-001, Rev.11	TestAmerica - Pittsburgh	Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP)	Metals (soils, excl. mercury)
PT-MT-007, Rev.9	TestAmerica - Pittsburgh	Preparation and Analysis of Mercury in Solid Samples by Cold Vapor Atomic Absorption	Mercury (soil)
PT-MT-005, Rev. 9	TestAmerica - Pittsburgh	Preparation and Analysis of Mercury in Aqueous Samples by Cold Vapor Atomic Absorption	Mercury (aqueous)
PT-WC-008 R4_AVS_SEM_F, Rev. 4	TestAmerica - Pittsburgh	Acid Volatile Sulfides (AVS) and Simultaneously Extracted Metals (SEM) in Sediment	AVS/SEM
LAM-023, Rev 2.0	ECCS Mobile Lab	Diesel Range Organics	DRO/ORO
KNOX-ID-0016, Rev 8	TestAmerica – Knoxville	Isotope Dilution Analysis of Selected Semivolatile Organic Compounds and Alkylated PAHs by Gas Chromatography/Mass Spectrometry - Selected Ion Monitoring	Parent and alkylated PAHs by isotope dilution and selected ion monitoring
PS-GCV-001, Rev.6	TestAmerica - Pensacola	Gasoline Range Organics (GRO)	GRO

Table 9. Fixed and Mobile Laboratory Instrument Maintenance and Calibration.

Instrument	Maintenance Activity	Testing/ Inspection Activities	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)
GC/MS (VOC soil)	Clean sources and quadrupole rods; maintain vacuum pumps	Tuning/ instrument performance and sensitivity	IC: Initial setup; after major maintenance; or after CCV failure. ICV: after each IC CCV: Every 12 hours	IC: Minimum of 5 point curve with %RSD ≤30 for CCCs; if %RSD >15%, use curve fit r^2>0.990;no single analyte %RSD >45% ICV: <20% RSD; no single analyte >60% RSD CCV : <20% difference for CCCs; non-CCC and non-SPCC average %D <20% and no single analyte %D >60% See SOP for details	Perform maintenance and recalibrate See SOP for details
GC/MS (VOC water)	Clean sources and quadrupole rods; maintain vacuum pumps	Tuning/ instrument performance and sensitivity	IC: Initial setup; after major maintenance; or after CCV failure. ICV: after each IC CCV: Every 12 hours	IC: Minimum of 5 point curve with %RSD ≤30 for CCCs; if mean %RSD <15% and each analyte <30% use avg RRF all, if any analyte >30% use curve fit r^2>0.990 ICV: <20% RSD for CCCs; no single analyte >30% RSD with 6 exceptions per SOP. ICV: <20% RSD for CCCs; no single analyte >30% RSD with 6 exceptions per SOP. See SOP for details	Perform maintenance and recalibrate See SOP for details
GC/MS (SVOC,PAHs)	Clean sources and quadrupole rods; maintain vacuum pumps	Tuning/ instrument performance and sensitivity	IC: Initial setup; after major maintenance; or after CCV failure. ICV: after each IC. CCV: Every 12 hours	IC: Minimum of 5 point curve with %RSD ≤30% for CCCs; if %RSD >15%, use curve fit r^2>0.990; no single analyte %RSD >60% ICV: <20% difference; no single analyte >60% difference CCV : <20% difference for CCCs; no single analyte %D >60% See SOP for details	Perform maintenance and recalibrate See SOP for details

Table 9. Fixed and Mobile Laboratory Instrument Maintenance and Calibration.

Instrument	Maintenance Activity	Testing/ Inspection Activities	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)
HRGC/HRMS (PCB – Congeners)	Clean sources; maintain vacuum pumps	Tuning/ instrument performance and sensitivity	IC: Initial setup; after major maintenance; or after CCV failure. CCV: Every 12 hours	IC: %RSD ≤20% for target analytes calculated by isotope dilution; %RSD ≤35% for target analytes calculated by internal standard CCV: ≤30% drift for Toxics and LOC congeners; 40-160% for non-toxic congeners See SOP for details	Perform maintenance and recalibrate See SOP for details
HRGC/HRMS (PCDD/PCDFs)	Clean sources; maintain vacuum pumps	Tuning/ instrument performance and sensitivity	IC: Initial setup; after major maintenance; or after CCV failure. CCV: Every 12 hours	IC: %RSD ≤20% for target analytes calculated by isotope dilution; %RSD ≤30% for target analytes calculated by internal standard CCV: ≤20% drift for native congeners; ≤30% for lableled congeners See SOP for details	Perform maintenance and recalibrate See SOP for details
GC/ECD (Pesticides)	Change septa, clean injectors, change or trim columns, install new liners	Detector signals and chromatogram review/instrument performance and sensitivity	IC: Initial setup; after major maintenance; or after CCV failure. ICV: prior to samples CCV:Every 12 hours or 20 samples (whichever is more frequent), beginning and end of run	IC: Five point curve;RSD <20%; r^2>0.990 ICV: <20% difference CCV: <20%D; no single analyte >60% See SOPs for details	Perform maintenance and recalibrate See SOP for details
GC/ECD (PCB – Aroclors)	Change septa, clean injectors, change or trim columns, install new liners	Detector signals and chromatogram review/instrument performance and sensitivity	IC: Initial setup; after major maintenance; or after CCV failure. ICV: prior to samples CCV: Every 12 hours or 20 samples (whichever is more frequent), beginning and end of run	IC: Five point curve;RSD <20%; r^2>0.990 ICV: <20% difference CCV: <15%D; no single analyte >60% See SOP for details	Perform maintenance and recalibrate See SOP for details
GC/PID/FID (GRO)	Change septa, clean injectors, change or trim columns, install new liners	Detector signals and chromatogram review/instrument performance and sensitivity	IC: Initial setup; after major maintenance; or after ICV or CCV failure. ICV: after each IC CCV: Prior to samples, every 24 hours or every 20 samples, whichever is more frequent and at end of run	IC: Minimum of five standards, %RSD ≤25, r ≥0.99 ICV: 80-120% recovery CCV: %D or %drift ≤25, except nonane (≤30). See SOP for details	Perform maintenance and recalibrate See SOP for details

Table 9. Fixed and Mobile Laboratory Instrument Maintenance and Calibration.

Instrument	Maintenance Activity	Testing/ Inspection Activities	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)
GC/FID (DRO)	Change septa, clean injectors, change or trim columns, install new liners	Detector signals and chromatogram review/instrument performance and sensitivity	IC: Initial setup; after major maintenance; or after ICV or CCV failure ICV: after each IC CCV: Every 12 hours and at end of run	IC: Minimum of five standards, %RSD ≤20 ICV: 70-130% recovery CCV: %D or %drift ≤20 See SOP for details	Perform maintenance and recalibrate See SOP for details
ICP/MS (Metals Analysis [excl. mercury])	Replace disposables, flush lines	Tuning/ instrument performance and sensitivity	IC: Daily, prior to analysis of samples ICV: Immediately following calibration CCV: After every 10 samples; beginning and end of run	IC: Minimum of one standard and one blank with correlation coefficient ≥0.998 for multi-point curves ICV: 90-110% recovery CCV: 90-110% recovery See SOP for details	Perform maintenance and recalibrate See SOP for details
ICP/AES (Metals Analysis [excl. mercury])	Replace disposables, flush lines	Verify intensity counts/ instrument performance and sensitivity	IC: Daily, prior to analysis of samples ICV: Immediately following calibration CCV: After every 10 samples; beginning and end of run	IC: Minimum of one standard and one blank with correlation coefficient ≥0.998 for multi-point curves ICV: 90-110% recovery CCV: 90-110% recovery See SOP for details	Perform maintenance and recalibrate See SOP for details
CVAA (Mercury Analysis)	Replace disposables, flush lines	Sensitivity check/ check connections	IC: Daily, prior to analysis of samples ICV: Immediately following calibration CCV: After every 10 samples; beginning and end of run	IC: Five standards and one blank with correlation coefficient ≥0.995. ICV: 90-110% recovery CCV: 80-120% recovery	Perform maintenance and recalibrate See SOP for details

ICV – Initial calibration verification
CCV – Continuing calibration verification
RSD – Relative standard deviation
SPCC – System performance check compounds
RF – Response factor
CCC – Calibration check compound
LCS – Laboratory control sample
LOC – Level of chlorination
D – Difference

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Appendix A

Laboratory Standard Operating Procedures

****** Laboratory SOPs are proprietary business information to be shared for review among Pepco, AECOM, and DDOE only ******

Appendix B

Additional Information for Table 1

Analysis Group Description	**Method Description**	**Method Code**								
Soil Analysis	**Organochlorine Pesticides and Polychlorinated Biphenyls by Gas Chromatography**	8082A								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	DCB Decachlorobiphenyl	2051-24-3							60	140
	PCB-1016	12674-11-2	70	130	20	60	140	20		
	PCB-1221	11104-28-2	70	130	20	60	140	20		
	PCB-1232	11141-16-5	70	130	20	60	140	20		
	PCB-1242	53469-21-9	70	130	20	60	140	20		
	PCB-1248	12672-29-6	70	130	20	60	140	20		
	PCB-1254	11097-69-1	70	130	20	60	140	20		
	PCB-1260	11096-82-5	70	130	20	60	140	20		
	Tetrachloro-m-xylene	877-09-8							60	140
	PCB-1262	37324-23-5	NA	NA	NA	NA	NA	NA		
	PCB-1268	11100-14-4	NA	NA	NA	NA	NA	NA		

Analysis Group Description	Method Description	Method Code								
Soil Analysis	**Organochlorine Pesticides and Polychlorinated Biphenyls by Gas Chromatography**	8081A_8082A								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	Aldrin	309-00-2	50	150	20	50	150	20		
	alpha-BHC	319-84-6	50	150	20	50	150	20		
	beta-BHC	319-85-7	50	150	20	50	150	20		
	delta-BHC	319-86-8	20	124	20	20	124	20		
	gamma-BHC (Lindane)	58-89-9	50	150	20	50	150	20		
	alpha-Chlordane	5103-71-9	50	150	20	50	150	20		
	gamma-Chlordane	5103-74-2	50	150	24	50	150	24		
	4,4'-DDD	72-54-8	50	150	20	50	150	20		
	4,4'-DDE	72-55-9	50	150	20	50	150	20		
	4,4'-DDT	50-29-3	50	150	37	50	150	37		
Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**	**Analyte Description**
	Dieldrin	60-57-1	50	150	20	50	150	20		
	Endosulfan I	959-98-8	50	150	23	50	150	23		
	Endosulfan II	33213-65-9	50	150	33	50	150	33		
	Endosulfan sulfate	1031-07-8	44	140	26	44	140	26		
	Endrin	72-20-8	50	150	20	50	150	20		
	Endrin aldehyde	7421-93-4	50	150	20	50	150	20		
	Endrin ketone	53494-70-5	50	150	20	50	150	20		
	Heptachlor	76-44-8	50	150	20	50	150	20		
	Heptachlor epoxide	1024-57-3	50	150	20	50	150	20		
	Methoxychlor	72-43-5	50	150	26	50	150	26		
	Toxaphene	8001-35-2								
	Tetrachloro-m-xylene	877-09-8							45	140
	DCB Decachlorobiphenyl (Surr)	2051-24-3							45	140

Analysis Group Description	**Method Description**	**Method Code**								
Soil Analysis	Closed System Purge and Trap (Low-Level)	5035A								
Soil Analysis	**Volatile Organic Compounds (GC/MS)**	8260B								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	1,1,1-Trichloroethane	71-55-6	67	126	31	67	126	31		
	1,1,2,2-Tetrachloroethane	79-34-5	60	139	24	60	139	24		
	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	55	130	37	55	130	37		
	1,1,2-Trichloroethane	79-00-5	70	128	22	70	128	22		
	1,1-Dichloroethane	75-34-3	66	124	23	66	124	23		
	1,1-Dichloroethene	75-35-4	59	129	25	59	129	25		
	1,2,3-Trichlorobenzene	87-61-6	37	144	40	37	144	40		
	1,2,4-Trichlorobenzene	120-82-1	51	136	40	51	136	40		
	1,2-Dibromo-3-Chloropropane	96-12-8	35	136	40	35	136	40		
	1,2-Dibromoethane (EDB)	106-93-4	70	131	20	70	131	20		
	1,2-Dichlorobenzene	95-50-1	71	124	22	71	124	22		
	1,2-Dichloroethane	107-06-2	61	127	23	61	127	23		
	1,2-Dichloroethane-d4 (Surr)	17060-07-0							52	124
	1,2-Dichloropropane	78-87-5	72	122	20	72	122	20		
	1,3-Dichlorobenzene	541-73-1	75	118	20	75	118	20		
	1,4-Dichlorobenzene	106-46-7	77	116	20	77	116	20		
	1,4-Dioxane	123-91-1	10	160	40	10	160	40		
	2-Butanone (MEK)	78-93-3	35	149	36	35	149	36		
	2-Hexanone	591-78-6	32	150	32	32	150	32		
	4-Bromofluorobenzene (Surr)	460-00-4							63	120
	4-Methyl-2-pentanone (MIBK)	108-10-1	44	148	30	44	148	30		
	Acetone	67-64-1	20	150	40	20	150	40		
	Benzene	71-43-2	77	120	20	77	120	20		
	Bromochloromethane	74-97-5	67	126	29	67	126	29		
	Bromodichloromethane	75-27-4	70	125	21	70	125	21		

Analysis Group Description	**Method Description**	**Method Code**								
Soil Analysis	Closed System Purge and Trap (Low-Level)	5035A								
Soil Analysis	**Volatile Organic Compounds (GC/MS)**	8260B								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	Bromoform	75-25-2	53	140	23	53	140	23		
	Bromomethane	74-83-9	25	150	40	25	150	40		
	Carbon disulfide	75-15-0	50	127	23	50	127	23		
	Carbon tetrachloride	56-23-5	69	122	22	69	122	22		
	Chlorobenzene	108-90-7	79	120	20	79	120	20		
	Chloroethane	75-00-3	22	150	40	22	150	40		
	Chloroform	67-66-3	72	120	25	72	120	25		
	Chloromethane	74-87-3	44	131	27	44	131	27		
	cis-1,2-Dichloroethene	156-59-2	80	118	20	80	118	20		
	cis-1,3-Dichloropropene	10061-01-5	73	120	20	73	120	20		
	Cyclohexane	110-82-7	64	130	21	64	130	21		
	Dibromochloromethane	124-48-1	70	132	20	70	132	20		
	Dibromofluoromethane (Surr)	1868-53-7							68	121
	Dichlorodifluoromethane	75-71-8	25	150	34	25	150	34		
	Ethylbenzene	100-41-4	78	125	21	78	125	21		
	Isopropylbenzene	98-82-8	70	133	22	70	133	22		
	Methyl acetate	79-20-9	27	142	40	27	142	40		
	Methyl tert-butyl ether	1634-04-4	48	132	36	48	132	36		
	Methylcyclohexane	108-87-2	66	135	23	66	135	23		
	Methylene Chloride	75-09-2	58	127	28	58	127	28		
	m-Xylene & p-Xylene	179601-23-1	75	126	21	75	126	21		
	o-Xylene	95-47-6	83	127	20	83	127	20		
	Styrene	100-42-5	83	129	20	83	129	20		
	Tetrachloroethene	127-18-4	78	129	20	78	129	20		
	Toluene	108-88-3	78	124	21	78	124	21		

Analysis Group Description	**Method Description**	**Method Code**								
Soil Analysis	Closed System Purge and Trap (Low-Level)	5035A								
Soil Analysis	**Volatile Organic Compounds (GC/MS)**	8260B								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	Toluene-d8 (Surr)	2037-26-5							72	127
	trans-1,2-Dichloroethene	156-60-5	77	121	20	77	121	20		
	trans-1,3-Dichloropropene	10061-02-6	74	129	20	74	129	20		
	Trichloroethene	79-01-6	76	119	21	76	119	21		
	Trichlorofluoromethane	75-69-4	20	150	40	20	150	40		
	Vinyl chloride	75-01-4	63	124	27	63	124	27		
	Xylenes, Total	1330-20-7	83	126	20	83	126	20		

Analysis Group Description	Method Description	Method Code								
Water Analysis	Liquid-Liquid Extraction (Separatory Funnel)	3510C								
Aqueous Analysis	**Organochlorine Pesticides and Polychlorinated Biphenyls by Gas Chromatography**	8081A_8082A								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	PCB-1016	12674-11-2	60	110	27	60	110	27		
	PCB-1221	11104-28-2								
	PCB-1232	11141-16-5								
	PCB-1242	53469-21-9								
	PCB-1248	12672-29-6								
	PCB-1254	11097-69-1								
	PCB-1260	11096-82-5	60	111	24	60	111	24		
	DCB Decachlorobiphenyl (Surr)	2051-24-3							50	140
	Tetrachloro-m-xylene	877-09-8							47	150

Analysis Group Description	Method Description	Method Code								
Aqueous Analysis	**Organochlorine Pesticides and Polychlorinated Biphenyls by Gas Chromatography**	8081A_8082A								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	4,4'-DDD	72-54-8	48	120	24	48	120	24		
	4,4'-DDE	72-55-9	47	120	20	47	120	20		
	4,4'-DDT	50-29-3	39	131	24	39	131	24		
	Aldrin	309-00-2	62	113	22	62	113	22		
	alpha-BHC	319-84-6	58	114	20	58	114	20		
	alpha-Chlordane	5103-71-9	59	114	21	59	114	21		
	beta-BHC	319-85-7	52	120	24	52	120	24		
	DCB Decachlorobiphenyl (Surr)	2051-24-3							56	122
	delta-BHC	319-86-8	10	137	26	10	137	26		
	Dieldrin	60-57-1	51	121	20	51	121	20		
	Endosulfan I	959-98-8	60	114	22	60	114	22		
	Endosulfan II	33213-65-9	58	112	21	58	112	21		
	Endosulfan sulfate	1031-07-8	42	122	21	42	122	21		
	Endrin	72-20-8	31	138	24	31	138	24		
	Endrin aldehyde	7421-93-4	52	110	25	52	110	25		
	Endrin ketone	53494-70-5	57	114	20	57	114	20		
	gamma-BHC (Lindane)	58-89-9	57	110	21	57	110	21		
	gamma-Chlordane	5103-74-2	60	114	21	60	114	21		
	Heptachlor	76-44-8	63	120	25	63	120	25		
	Heptachlor epoxide	1024-57-3	60	120	20	60	120	20		
	Methoxychlor	72-43-5	35	137	27	35	137	27		
	Tetrachloro-m-xylene	877-09-8							60	111
	Toxaphene	8001-35-2								

Analysis Group Description	**Method Description**	**Method Code**								
Soil Analysis	Automated Soxhlet Extraction	3541								
Aqueous Analysis	**Semivolatile Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)**	8270C								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	1,1'-Biphenyl	92-52-4	30	150	40	30	150	40		
	1,2,4,5-Tetrachlorobenzene	95-94-3	30	125	25	30	125	25		
	2,2'-oxybis[1-chloropropane]	108-60-1	36	101	41	36	101	41		
	2,3,4,6-Tetrachlorophenol	58-90-2	38	113	83	38	113	83		
	2,4,5-Trichlorophenol	95-95-4	48	108	44	48	108	44		
	2,4,6-Tribromophenol	118-79-6							35	124
	2,4,6-Trichlorophenol	88-06-2	50	106	42	50	106	42		
	2,4-Dichlorophenol	120-83-2	47	105	35	47	105	35		
	2,4-Dimethylphenol	105-67-9	44	105	49	44	105	49		
	2,4-Dinitrophenol	51-28-5	10	146	83	10	146	83		
	2,4-Dinitrotoluene	121-14-2	45	124	41	45	124	41		
	2,6-Dinitrotoluene	606-20-2	50	122	40	50	122	40		
	2-Chloronaphthalene	91-58-7	46	101	40	46	101	40		
	2-Chlorophenol	95-57-8	40	101	42	40	101	42		
	2-Fluorobiphenyl	321-60-8							35	105
	2-Fluorophenol	367-12-4							39	103
	2-Methylnaphthalene	91-57-6	45	100	40	45	100	40		
	2-Methylphenol	95-48-7	40	104	41	40	104	41		
	2-Nitroaniline	88-74-4	45	117	42	45	117	42		
	2-Nitrophenol	88-75-5	46	106	39	46	106	39		
	3,3'-Dichlorobenzidine	91-94-1	19	122	40	19	122	40		
	3-Nitroaniline	99-09-2	34	122	39	34	122	39		
	4,6-Dinitro-2-methylphenol	534-52-1	24	134	87	24	134	87		
	4-Bromophenyl phenyl ether	101-55-3	47	110	46	47	110	46		
	4-Chloro-3-methylphenol	59-50-7	47	109	36	47	109	36		

Analysis Group Description	**Method Description**	**Method Code**								
Soil Analysis	Automated Soxhlet Extraction	3541								
Aqueous Analysis	**Semivolatile Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)**	8270C								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	4-Chloroaniline	106-47-8	25	108	36	25	108	36		
	4-Chlorophenyl phenyl ether	7005-72-3	47	109	39	47	109	39		
	4-Nitroaniline	100-01-6	38	123	40	38	123	40		
	4-Nitrophenol	100-02-7	36	127	43	36	127	43		
	Acenaphthene	83-32-9	47	104	40	47	104	40		
	Acenaphthylene	208-96-8	49	114	38	49	114	38		
	Acetophenone	98-86-2	30	150	40	30	150	40		
	Anthracene	120-12-7	45	112	42	45	112	42		
	Atrazine	1912-24-9	30	150	40	30	150	40		
	Benzaldehyde	100-52-7	30	150	40	30	150	40		
	Benzo[a]anthracene	56-55-3	47	110	40	47	110	40		
	Benzo[a]pyrene	50-32-8	47	112	42	47	112	42		
	Benzo[b]fluoranthene	205-99-2	41	107	53	41	107	53		
	Benzo[g,h,i]perylene	191-24-2	38	126	43	38	126	43		
	Benzo[k]fluoranthene	207-08-9	44	115	44	44	115	44		
	Bis(2-chloroethoxy)methane	111-91-1	44	101	36	44	101	36		
	Bis(2-chloroethyl)ether	111-44-4	38	99	43	38	99	43		
	Bis(2-ethylhexyl) phthalate	117-81-7	40	122	41	40	122	41		
	Butyl benzyl phthalate	85-68-7	41	118	41	41	118	41		
	Caprolactam	105-60-2	30	150	40	30	150	40		
	Carbazole	86-74-8	45	114	36	45	114	36		
	Chrysene	218-01-9	46	111	39	46	111	39		
	Dibenz(a,h)anthracene	53-70-3	39	127	45	39	127	45		
	Dibenzofuran	132-64-9	46	104	38	46	104	38		
	Diethyl phthalate	84-66-2	47	115	38	47	115	38		

Analysis Group Description	**Method Description**	**Method Code**								
Soil Analysis	Automated Soxhlet Extraction	3541								
Aqueous Analysis	**Semivolatile Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)**	8270C								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	Dimethyl phthalate	131-11-3	49	111	37	49	111	37		
	Di-n-butyl phthalate	84-74-2	43	121	38	43	121	38		
	Di-n-octyl phthalate	117-84-0	33	129	41	33	129	41		
	Fluoranthene	206-44-0	40	120	36	40	120	36		
	Fluorene	86-73-7	46	109	40	46	109	40		
	Hexachlorobenzene	118-74-1	47	108	43	47	108	43		
	Hexachlorobutadiene	87-68-3	43	107	39	43	107	39		
	Hexachlorocyclopentadiene	77-47-4	23	129	49	23	129	49		
	Hexachloroethane	67-72-1	37	97	48	37	97	48		
	Indeno[1,2,3-cd]pyrene	193-39-5	41	125	47	41	125	47		
	Isophorone	78-59-1	47	110	37	47	110	37		
	Methylphenol, 3 & 4	106-44-5	42	105	43	42	105	43		
	Naphthalene	91-20-3	43	100	32	43	100	32		
	Nitrobenzene	98-95-3	43	104	33	43	104	33		
	Nitrobenzene-d5	4165-60-0							25	104
	N-Nitrosodi-n-propylamine	621-64-7	42	107	43	42	107	43		
	N-Nitrosodiphenylamine	86-30-6	44	111	40	44	111	40		
	Pentachlorophenol	87-86-5	17	122	52	17	122	52		
	Phenanthrene	85-01-8	43	108	39	43	108	39		
	Phenol	108-95-2	41	102	39	41	102	39		
	Phenol-d5	4165-62-2							25	105

Analysis Group Description	**Method Description**	**Method Code**								
Aqueous Analysis	Purge and Trap	5030B								
Aqueous Analysis	**Volatile Organic Compounds (GC/MS)**	8260B								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	1,1,1,2-Tetrachloroethane	630-20-6	63	140	34	63	140	34		
	1,1,1-Trichloroethane	71-55-6	63	133	35	63	133	35		
	1,1,2,2-Tetrachloroethane	79-34-5	62	125	35	62	125	35		
	1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	46	148	35	46	148	35		
	1,1,2-Trichloroethane	79-00-5	77	127	35	77	127	35		
	1,1-Dichloroethane	75-34-3	73	126	35	73	126	35		
	1,1-Dichloroethene	75-35-4	65	136	35	65	136	35		
	1,1-Dichloropropene	563-58-6	74	123	35	74	123	35		
	1,2,3-Trichlorobenzene	87-61-6	59	127	35	59	127	35		
	1,2,3-Trichloropropane	96-18-4	66	125	35	66	125	35		
	1,2,4-Trichlorobenzene	120-82-1	60	127	35	60	127	35		
	1,2,4-Trimethylbenzene	95-63-6	71	122	30	71	122	30		
	1,2-Dibromo-3-Chloropropane	96-12-8	37	133	35	37	133	35		
	1,2-Dibromoethane (EDB)	106-93-4	74	123	35	74	123	35		
	1,2-Dichlorobenzene	95-50-1	77	120	24	77	120	24		
	1,2-Dichloroethane	107-06-2	68	132	32	68	132	32		
	1,2-Dichloroethane-d4 (Surr)	17060-07-0							64	135
	1,2-Dichloroethene, Total	540-59-0	71	124	35	71	124	35		
	1,2-Dichloropropane	78-87-5	76	124	34	76	124	34		
	1,3,5-Trichlorobenzene	108-70-3	58	132	35	58	132	35		
	1,3,5-Trimethylbenzene	108-67-8	70	126	33	70	126	33		
	1,3-Dichlorobenzene	541-73-1	76	120	24	76	120	24		
	1,3-Dichloropropane	142-28-9	76	124	36	76	124	36		
	1,4-Dichlorobenzene	106-46-7	77	120	24	77	120	24		
	1,4-Dichlorobenzene-d4	3855-82-1								

Analysis Group Description	**Method Description**	**Method Code**								
Aqueous Analysis	Purge and Trap	5030B								
Aqueous Analysis	**Volatile Organic Compounds (GC/MS)**	8260B								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	1,4-Dioxane	123-91-1	10	160	35	10	160	35		
	2,2-Dichloropropane	594-20-7	52	131	35	52	131	35		
	2,3- & 3,4- Dichlorotoluene	STL01556	66	122	30	66	122	30		
	2,3,6-Trichlorotoluene	2077-46-5	32	144	35	32	144	35		
	2,4- & 2,5- & 2,6-Dichlorotoluene	STL01557	66	126	26	66	126	26		
	2,4,5-Trichlorotoluene	6639-30-1	38	132	35	38	132	35		
	2,4-Dichlorobenzotrifluoride	320-60-5	69	129	32	69	129	32		
	2,5-Dichlorobenzotrifluoride	320-50-3	65	127	35	65	127	35		
	2-Butanone (MEK)	78-93-3	39	138	35	39	138	35		
	2-Chlorobenzotrifluoride	88-16-4	57	145	34	57	145	34		
	2-Chloroethyl vinyl ether	110-75-8	10	110	35	10	110	35		
	2-Chlorotoluene	95-49-8	69	122	33	69	122	33		
	2-Hexanone	591-78-6	25	132	35	25	132	35		
	3,4-Dichlorobenzotrifluoride	328-84-7	62	130	35	62	130	35		
	3-Chlorobenzotrifluoride	98-15-7	67	136	35	67	136	35		
	3-Chlorotoluene	108-41-8	70	130	35	70	130	35		
	4-Bromofluorobenzene (Surr)	460-00-4							70	118
	4-Chlorobenzotrifluoride	98-56-6	68	135	35	68	135	35		
	4-Chlorotoluene	106-43-4	73	120	30	73	120	30		
	4-Isopropyltoluene	99-87-6	56	131	35	56	131	35		
	4-Methyl-2-pentanone (MIBK)	108-10-1	45	145	35	45	145	35		
	Acetone	67-64-1	22	150	35	22	150	35		
	Acetonitrile	75-05-8	30	140	35	30	140	35		
	Acrolein	107-02-8	30	140	35	30	140	35		
	Acrylonitrile	107-13-1	30	140	35	30	140	35		

Analysis Group Description	**Method Description**	**Method Code**								
Aqueous Analysis	Purge and Trap	5030B								
Aqueous Analysis	**Volatile Organic Compounds (GC/MS)**	8260B								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	Allyl chloride	107-05-1			35			35		
	Benzene	71-43-2	80	120	32	80	120	32		
	Bromobenzene	108-86-1	77	120	29	77	120	29		
	Bromochloromethane	74-97-5	70	127	35	70	127	35		
	Bromodichloromethane	75-27-4	66	130	35	66	130	35		
	Bromoform	75-25-2	46	150	35	46	150	35		
	Bromomethane	74-83-9	33	150	35	33	150	35		
	Carbon disulfide	75-15-0	54	132	35	54	132	35		
	Carbon tetrachloride	56-23-5	55	150	35	55	150	35		
	Chlorobenzene	108-90-7	80	120	29	80	120	29		
	Chloroethane	75-00-3	36	142	35	36	142	35		
	Chloroform	67-66-3	72	127	35	72	127	35		
	Chloromethane	74-87-3	50	139	35	50	139	35		
	Chloroprene	126-99-8			35			35		
	cis-1,2-Dichloroethene	156-59-2	70	120	35	70	120	35		
	cis-1,3-Dichloropropene	10061-01-5	66	120	35	66	120	35		
	Cyclohexane	110-82-7	45	142	35	45	142	35		
	Dibromochloromethane	124-48-1	60	140	35	60	140	35		
	Dibromofluoromethane (Surr)	1868-53-7							70	128
	Dibromomethane	74-95-3	72	125	35	72	125	35		
	Dichlorodifluoromethane	75-71-8	13	150	35	13	150	35		
	Ethyl ether	60-29-7			35			35		
	Ethyl methacrylate	97-63-2			35			35		
	Ethylbenzene	100-41-4	72	126	33	72	126	33		
	Hexachlorobutadiene	87-68-3	38	147	35	38	147	35		
	Hexane	110-54-3			35			35		

Analysis Group Description	**Method Description**	**Method Code**								
Aqueous Analysis	Purge and Trap	5030B								
Aqueous Analysis	**Volatile Organic Compounds (GC/MS)**	8260B								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	Iodomethane	74-88-4			35			35		
	Isobutyl alcohol	78-83-1			35			35		
	Isopropylbenzene	98-82-8	58	130	35	58	130	35		
	Methacrylonitrile	126-98-7			35			35		
	Methyl acetate	79-20-9	47	142	35	47	142	35		
	Methyl methacrylate	80-62-6			35			35		
	Methyl tert-butyl ether	1634-04-4	64	123	35	64	123	35		
	Methylcyclohexane	108-87-2	45	145	35	45	145	35		
	Methylene Chloride	75-09-2	63	129	35	63	129	35		
	m-Xylene & p-Xylene	179601-23-1	73	130	32	73	130	32		
	Naphthalene	91-20-3	45	127	35	45	127	35		
	n-Butanol	71-36-3			35			35		
	n-Butylbenzene	104-51-8	49	134	34	49	134	34		
	n-Heptane	142-82-5								
	N-Propylbenzene	103-65-1	62	128	34	62	128	34		
	o-Xylene	95-47-6	72	124	33	72	124	33		
	Propionitrile	107-12-0			35			35		
	sec-Butylbenzene	135-98-8	55	132	33	55	132	33		
	Styrene	100-42-5	71	127	34	71	127	34		
	tert-Butyl alcohol	75-65-0			35			35		
	tert-Butylbenzene	98-06-6	55	128	35	55	128	35		
	Tetrachloroethene	127-18-4	70	135	35	70	135	35		
	Tetrahydrofuran	109-99-9			35			35		
	Toluene	108-88-3	80	123	35	80	123	35		
	Toluene-d8 (Surr)	2037-26-5							71	118
	trans-1,2-Dichloroethene	156-60-5	73	126	35	73	126	35		

Analysis Group Description	**Method Description**	**Method Code**								
Aqueous Analysis	Purge and Trap	5030B								
Aqueous Analysis	**Volatile Organic Compounds (GC/MS)**	8260B								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	trans-1,3-Dichloropropene	10061-02-6	65	125	35	65	125	35		
	trans-1,4-Dichloro-2-butene	110-57-6	40	100	30	40	100	30		
	Trichloroethene	79-01-6	73	120	35	73	120	35		
	Trichlorofluoromethane	75-69-4	44	150	35	44	150	35		
	Vinyl acetate	108-05-4	44	150	35	44	150	35		
	Vinyl chloride	75-01-4	53	138	35	53	138	35		
	Xylenes, Total	1330-20-7	76	128	32	76	128	32		

Analysis Group Description	Method Description	Method Code								
Aqueous Analysis	Liquid-Liquid Extraction	3520C								
Aqueous Analysis	**Semivolatile Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Low Level**	8270C								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	1,1'-Biphenyl	92-52-4	30	150	35	30	150	35		
	1,2,4,5-Tetrachlorobenzene	95-94-3	30	125	25	30	125	25		
	1,2,4-Trichlorobenzene	120-82-1	34	96	45	34	96	45		
	1,2-Dichlorobenzene	95-50-1	34	95	38	34	95	38		
	1,2-Diphenylhydrazine(as Azobenzene)	122-66-7	31	107	41	31	107	41		
	1,3-Dichlorobenzene	541-73-1	33	93	38	33	93	38		
	1,3-Dinitrobenzene	99-65-0	30	125	25	30	125	25		
	1,4-Dichlorobenzene	106-46-7	34	93	41	34	93	41		
	1,4-Dioxane	123-91-1	23	88	20	23	88	20		
	1-Methylnaphthalene	90-12-0	10	140	30	10	140	30		
	2,2'-oxybis[1-chloropropane]	108-60-1	30	99	42	30	99	42		
	2,3,4,6-Tetrachlorophenol	58-90-2	36	103	40	36	103	40		
	2,3,5,6-Tetrachlorophenol	935-95-5	31	107	38	31	107	38		
	2,4,5-Trichlorophenol	95-95-4	34	104	39	34	104	39		
	2,4,6-Tribromophenol	118-79-6							16	122
	2,4,6-Trichlorophenol	88-06-2	36	103	39	36	103	39		
	2,4-Dichlorophenol	120-83-2	34	104	41	34	104	41		
	2,4-Dimethylphenol	105-67-9	33	97	40	33	97	40		
	2,4-Dinitrophenol	51-28-5	10	130	53	10	130	53		
	2,4-Dinitrotoluene	121-14-2	37	115	39	37	115	39		
	2,5-Dichlorophenol	583-78-8								
	2,6-Dichlorophenol	87-65-0	30	125	25	30	125	25		
	2,6-Dinitrotoluene	606-20-2	39	113	40	39	113	40		
	2-Chloronaphthalene	91-58-7	34	96	39	34	96	39		

Analysis Group Description	**Method Description**	**Method Code**								
Aqueous Analysis	Liquid-Liquid Extraction	3520C								
Aqueous Analysis	**Semivolatile Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Low Level**	8270C								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	2-Chlorophenol	95-57-8	31	99	39	31	99	39		
	2-Fluorobiphenyl	321-60-8							19	107
	2-Fluorophenol	367-12-4							10	111
	2-Methylnaphthalene	91-57-6	34	98	42	34	98	42		
	2-Methylphenol	95-48-7	33	98	38	33	98	38		
	2-Naphthylamine	91-59-8	25	135	30	25	135	30		
	2-Nitroaniline	88-74-4	29	112	65	29	112	65		
	2-Nitrophenol	88-75-5	34	107	41	34	107	41		
	3,3'-Dichlorobenzidine	91-94-1	10	89	56	10	89	56		
	3-Nitroaniline	99-09-2	11	104	48	11	104	48		
	4,6-Dinitro-2-methylphenol	534-52-1	24	124	41	24	124	41		
	4-Bromophenyl phenyl ether	101-55-3	37	104	40	37	104	40		
	4-Chloro-3-methylphenol	59-50-7	35	104	42	35	104	42		
	4-Chloroaniline	106-47-8	10	99	39	10	99	39		
	4-Chlorophenyl phenyl ether	7005-72-3	34	103	38	34	103	38		
	4-Nitroaniline	100-01-6	20	124	45	20	124	45		
	4-Nitrophenol	100-02-7	29	115	42	29	115	42		
	7,12-Dimethylbenz(a)anthracene	57-97-6	10	140	30	10	140	30		
	Acenaphthene	83-32-9	35	99	41	35	99	41		
	Acenaphthylene	208-96-8	37	107	40	37	107	40		
	Acetophenone	98-86-2	30	150	35	30	150	35		
	Aniline	62-53-3	21	86	20	21	86	20		
	Anthracene	120-12-7	35	105	37	35	105	37		
	Atrazine	1912-24-9	30	150	35	30	150	35		

Analysis Group Description	**Method Description**	**Method Code**								
Aqueous Analysis	Liquid-Liquid Extraction	3520C								
Aqueous Analysis	**Semivolatile Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Low Level**	8270C								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	Benzaldehyde	100-52-7	30	150	35	30	150	35		
	Benzidine	92-87-5	10	150	30	10	150	30		
	Benzo[a]anthracene	56-55-3	38	101	36	38	101	36		
	Benzo[a]pyrene	50-32-8	26	108	40	26	108	40		
	Benzo[b]fluoranthene	205-99-2	29	98	46	29	98	46		
	Benzo[g,h,i]perylene	191-24-2	20	115	44	20	115	44		
	Benzo[k]fluoranthene	207-08-9	28	107	31	28	107	31		
	Benzoic acid	65-85-0	10	114	59	10	114	59		
	Benzyl alcohol	100-51-6	10	68	20	10	68	20		
	Bis(2-chloroethoxy)methane	111-91-1	33	98	46	33	98	46		
	Bis(2-chloroethyl)ether	111-44-4	33	95	38	33	95	38		
	Bis(2-ethylhexyl) phthalate	117-81-7	20	116	40	20	116	40		
	Butyl benzyl phthalate	85-68-7	36	108	40	36	108	40		
	Caprolactam	105-60-2	30	150	35	30	150	35		
	Carbazole	86-74-8	29	112	35	29	112	35		
	Chlorophene	120-32-1	40	150	30	40	150	30		
	Chrysene	218-01-9	37	99	42	37	99	42		
	Cresols, Total	1319-77-3	29	144	33	29	144	33		
	Dibenz(a,h)anthracene	53-70-3	19	118	44	19	118	44		
	Dibenz[a,h]acridine	226-36-8	51	115	35	51	115	35		
	Dibenzofuran	132-64-9	34	101	39	34	101	39		
	Dibromoacetonitrile	3252-43-5								
	Diethyl phthalate	84-66-2	36	109	39	36	109	39		
	Dimethyl phthalate	131-11-3	37	106	42	37	106	42		
	Di-n-butyl phthalate	84-74-2	37	111	38	37	111	38		

Analysis Group Description	**Method Description**	**Method Code**								
Aqueous Analysis	Liquid-Liquid Extraction	3520C								
Aqueous Analysis	**Semivolatile Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Low Level**	8270C								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	Di-n-octyl phthalate	117-84-0	11	127	44	11	127	44		
	Diphenamid	957-51-7	30	140	30	30	140	30		
	Fluorene	86-73-7	34	104	40	34	104	40		
	Hexachlorobenzene	118-74-1	35	102	35	35	102	35		
	Hexachlorobutadiene	87-68-3	35	100	41	35	100	41		
	Hexachlorocyclopentadiene	77-47-4	36	115	47	36	115	47		
	Hexachloroethane	67-72-1	32	94	39	32	94	39		
	Indene	95-13-6	10	140	30	10	140	30		
	Indeno[1,2,3-cd]pyrene	193-39-5	22	115	54	22	115	54		
	Isophorone	78-59-1	38	102	43	38	102	43		
	Methylphenol, 3 & 4	106-44-5	32	100	41	32	100	41		
	Naphthalene	91-20-3	35	97	43	35	97	43		
	Nitrobenzene	98-95-3	37	100	42	37	100	42		
	Nitrobenzene-d5	4165-60-0							23	112
	N-Nitrosodiethylamine	55-18-5	31	107	40	31	107	40		
	N-Nitrosodimethylamine	62-75-9	10	150	35	10	150	35		
	N-Nitrosodi-n-butylamine	924-16-3	34	101	43	34	101	43		
	N-Nitrosodi-n-propylamine	621-64-7	32	102	36	32	102	36		
	N-Nitrosopiperidine	100-75-4	10	140	30	10	140	30		
	Pentachlorophenol	87-86-5	15	111	42	15	111	42		
	Phenanthrene	85-01-8	32	104	36	32	104	36		
	Phenol-d5	4165-62-2							15	112
	Phenol	108-95-2	32	95	39	32	95	39		
	Pyrene	129-00-0	35	106	42	35	106	42		
	Pyridine	110-86-1	26	96	46	26	96	46		

Analysis Group Description	Method Description	Method Code								
Aqueous Analysis	Liquid-Liquid Extraction	3520C								
Aqueous Analysis	**Semivolatile Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Low Level**	8270C								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC Recovery Low %**	**SUREC Recovery High %**
	Terphenyl-d14	1718-51-0							10	132

Analysis Group Description	**Method Description**	**Method Code**								
Aqueous/Soil Analysis	**PCB-Congeners by HRGC/HRMS**	1668A								
	Analyte Description	**IUPAC Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC *Recovery Low %**	**SUREC *Recovery High %**
	2-MoCB	1	50	150	NA	NA	NA	NA	30	140
	4-MoCB	3	50	150	NA	NA	NA	NA	30	140
	2,2'-DiCB	4	50	150	NA	NA	NA	NA	30	140
	4,4'-DiCB	15	50	150	NA	NA	NA	NA	30	140
	2,2',6-TrCB	19	50	150	NA	NA	NA	NA	30	140
	3,4,4'-TrCB	37	50	150	NA	NA	NA	NA	30	140
	2,2',6,6'-TeCB	54	50	150	NA	NA	NA	NA	30	140
	3,3',4,4'-TeCB3,6	77	50	150	NA	NA	NA	NA	30	140
	3,4,4',5-TeCB6	81	50	150	NA	NA	NA	NA	30	140
	2,2',4,6,6'-PeCB	104	50	150	NA	NA	NA	NA	30	140
	2,3,3',4,4'-PeCB3,6	105	50	150	NA	NA	NA	NA	30	140
	2,3,4,4',5-PeCB6	114	50	150	NA	NA	NA	NA	30	140
	2,3',4,4',5-PeCB3,6	118	50	150	NA	NA	NA	NA	30	140
	2',3,4,4',5-PeCB6	123	50	150	NA	NA	NA	NA	30	140
	3,3',4,4',5-PeCB3,6	126	50	150	NA	NA	NA	NA	30	140
	2,2',4,4',6,6'-HxCB	155	50	150	NA	NA	NA	NA	30	140
	2,3,3',4,4',5-HxCB6	156	50	150	NA	NA	NA	NA	30	140
	2,3,3',4,4',5'-HxCB6	157	50	150	NA	NA	NA	NA	30	140
	2,3',4,4',5,5'-HxCB6	167	50	150	NA	NA	NA	NA	30	140
	3,3',4,4',5,5'-HxCB3,6	169	50	150	NA	NA	NA	NA	30	140
	2,2',3,3',4,4',5-HpCB3	170	50	150	NA	NA	NA	NA	30	140
	2,2',3,4',5,6,6'-HpCB	188	50	150	NA	NA	NA	NA	30	140
	2,3,3',4,4',5,5'-HpCB6	189	50	150	NA	NA	NA	NA	30	140
	2,2',3,3',5,5',6,6'-OcCB	202	50	150	NA	NA	NA	NA	30	140
	2,3,3',4,4',5,5',6-OcCB	205	50	150	NA	NA	NA	NA	30	140
	2,2',3,3',4,4',5,5',6-NoCB3	206	50	150	NA	NA	NA	NA	30	140
	2,2',3,3',4,5,5',6,6'-NoCB	208	50	150	NA	NA	NA	NA	30	140
	DeCB3	209	50	150	NA	NA	NA	NA	30	140

Analysis Group Description	Method Description	Method Code								
Aqueous/Soil Analysis	PCDD/PCDFs by HRGC/HRMS	8290A								
	Analyte Description	**CAS Number**	**LCSREC Recovery Low %**	**LCSREC Recovery High %**	**LCSRPD Precision %**	**MSREC Recovery Low %**	**MSREC Recovery High %**	**MSRPD Precision %**	**SUREC *Recovery Low %**	**SUREC *Recovery High %**
	1,2,3,4,6,7,8-HPCDD	35822-46-9	50	150	NA	NA	NA	NA	30	140
	1,2,3,4,6,7,8-HPCDF	67562-39-4	50	150	NA	NA	NA	NA	30	140
	1,2,3,4,7,8-HxCDD	39227-28-6	50	150	NA	NA	NA	NA	30	140
	1,2,3,4,7,8-HXCDF	70648-26-9	50	150	NA	NA	NA	NA	30	140
	1,2,3,4,7,8,9-HPCDF	55673-89-7	50	150	NA	NA	NA	NA	30	140
	1,2,3,6,7,8-HxCDD	57653-85-7	50	150	NA	NA	NA	NA	30	140
	1,2,3,6,7,8-HXCDF	57117-44-9	50	150	NA	NA	NA	NA	30	140
	1,2,3,7,8,9-HxCDD	19408-74-3	50	150	NA	NA	NA	NA	30	140
	1,2,3,7,8,9-HXCDF	72918-21-9	50	150	NA	NA	NA	NA	30	140
	1,2,3,7,8-PeCDD	40321-76-4	50	150	NA	NA	NA	NA	30	140
	1,2,3,7,8-PECDF	57117-41-6	50	150	NA	NA	NA	NA	30	140
	2,3,4,6,7,8-HXCDF	60851-34-5	50	150	NA	NA	NA	NA	30	140
	2,3,4,7,8-PECDF	57117-31-4	50	150	NA	NA	NA	NA	30	140
	2,3,7,8-TCDD	1746-01-6	50	150	NA	NA	NA	NA	30	140
	2,3,7,8-TCDF	51207-31-9	50	150	NA	NA	NA	NA	30	140
	OCDD	3268-87-9	50	150	NA	NA	NA	NA	30	140
	OCDF	39001-02-0	50	150	NA	NA	NA	NA	30	140

Note all limits are subject to change based on final laboratory selection and required annual laboratory detection limit updates