Sediment Sampling Work Plan

Upriver Reach Sediment Investigation

Upriver Reach,
Lower Willamette River,
Portland, Oregon
ECSI #6220

Prepared for
Oregon Department of
Environmental Quality

October 25, 2019
150-002-017/Task 3

HARTCROWSER

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ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
COC	contaminant of concern
COI	contaminant of interest
cm	centimeter
Corps	U.S. Army Corps of Engineers
CUL	Cleanup Level
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DEQ	Oregon Department of Environmental Quality
DSL	Oregon Department of State Lands
ECSI	Environmental Cleanup Site Information
EDD	Electronic data deliverable
EPA	U.S. Environmental Protection Agency
FDR	Field and Data Report
Geosyntec	Geosyntec Consultants, Inc.
GSI	GSI Water Solutions, Inc.
HASP	Health and Safety Plan
MDL	method detection limit
NAVD 88	North American Vertical Datum of 1988
NGVD 29	National Geodetic Vertical Datum of 1929
PAH	polycyclic aromatic hydrocarbon
PBDE	polybrominated diphenyl ethers
PCB	polychlorinated biphenyl
PDI	Pre-Design Investigation
PHSS	Portland Harbor Superfund Site
PPE	personal protective equipment
Pre-RD AOC Group	Pre-Remedial Design Agreement and Order on Consent Investigation Group
PSEP	Puget Sound Estuary Protocols
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RAL	Remedial Action Level
RM	River Mile
ROD	Record of Decision
SLV	Screening Level Values
SQL	sample quantitation limit
SVOC	semivolatile organic compound
TEQ	toxic equivalency
TPHd	total petroleum hydrocarbons as diesel
VOC	volatile organic compound

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Portland, Oregon

1.0 INTRODUCTION

This Work Plan presents the scope of work for sampling and analyzing sediment from the Upriver Reach of the Lower Willamette River from two previous characterization areas at River Mile (RM) 16.0 to 16.5 East and RM 19.4 to 19.7 West (Figure 1). This Work Plan was prepared by Hart Crowser and GSI Water Solutions, Inc. (GSI), for the Oregon Department of Environmental Quality (DEQ) under Task 3 of Task Order 72-18-17 and will be implemented under Task 4. DEQ has designated select portions of the Upriver Reach as an orphan site in their Environmental Cleanup Site Information (ECSI) database as ECSI #6220.

1.1 Purpose

In 2018, a group of potentially responsible parties called the Pre-Remedial Design Agreement and Order on Consent Investigation Group (Pre-RD AOC Group) completed a pre-design investigation (PDI) of the Portland Harbor Superfund Site (PHSS). The Upriver Reach, from approximately RM 16 to 28, of the Lower Willamette River was included in this PDI to provide baseline data on upstream (background) conditions to the PHSS. Based on these data, DEQ identified surface sediment contamination in two discrete areas with elevated levels of dioxins/furans, organochlorine pesticides, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyl (PCBs) that warranted additional characterization: 1) from RM 16.0 to 16.3 East, offshore of Sellwood Riverfront Park and Oaks Amusement Park; and 2) at RM 19.6 West, in an area of sediment deposition and offshore of a residential area. The purpose of the investigation proposed in this Work Plan is to collect additional sediment data to further assess the extent of contaminants of interest (COIs) in the area of these samples. The data generated will also be of sufficient quality to evaluate potential sources of contamination and risks to human health and the environment.

1.2 Scope of Work

To gather the additional data for further assessment, the scope of work described in this Work Plan consists of the following general tasks:

- Collecting surface sediment samples from the Willamette River bottom using a power-grab sampler at five locations from RM 16.0 to 16.5 East and from RM 19.4 to 19.7 West.
- Collecting three shoreline sediment samples in the area of potential historical or current stormwater outfalls/drainages along the east shoreline of the Willamette River between RM 16.3 and 16.5.
- Analyzing samples for conventional parameters, metals, dioxins/furans, total petroleum hydrocarbons as diesel (TPHd), organochlorine pesticides, semivolatile organic compounds (SVOCs) including PAHs, polybrominated diphenyl ethers (PBDEs) congeners, and PCB congeners.

- Preparing a Field and Data Report (FDR) discussing field activities, the analytical results, and evaluation of the data with the PDI data and relative to DEQ Level II Ecological Screening Level Values (SLVs) for sediment and also Cleanup Levels (CULs) and Remedial Action Levels (RALs) listed in the PHSS Record of Decision (ROD; EPA 2017).

Sample collection and analysis will be conducted in a manner consistent with Surface Sediment Field Sampling Plan, Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling, Portland Harbor Superfund Site (AECOM and Geosyntec 2018). The DEQ QAPP provides a framework for sample collection and analysis that is applicable to this project and used to develop the quality assurance/ quality control (QA/QC) protocols that are discussed in Section 5.

1.3 Work Plan Organization

Following this introduction, this Work Plan is organized into the following sections:

- **Section 2 – Background.** This section provides a description of the physical setting and previous investigations.
- **Section 3 – Sampling and Analytical Approach.** This section describes the data collection goals and the rationale for selection of sample locations.
- **Section 4 – Sampling Activities.** This section details sampling methods, collection, and handling procedures for sampling activities.
- **Section 5 – Analytical and QA/QC Program.** This section presents the analytical requirements and procedures for testing and interpreting chemical analytical results of the sediment samples, including QA/QC procedures to ensure sample integrity and data quality.
- **Section 6 – Data Management.** This section details procedures for recording and storing field and analytical data generated during this investigation
- **Section 7 – Project Schedule and Reporting.** This section outlines the anticipated project schedule and describes the FDR that will be generated following completion of investigation activities.
- **Section 8 – References.** This section lists documents referenced within the text of this Work Plan.

1.4 Limitations

This Work Plan has been prepared for DEQ. Work for this project will be performed in accordance with generally accepted professional practices relating to the nature of work completed at the same or similar localities. It is intended for the exclusive use of the DEQ for specific application to the site. No other warranty, express or implied, is made.

2.0 BACKGROUND

This section presents a brief description of the site and previous investigation activities. Information is summarized from existing documents. Please refer to cited documents for additional detailed information. References are provided in Section 8.

2.1 Physical Setting

The Upriver Reach of the Lower Willamette River extends from RM 16.6 to 28.4, as defined by the U.S. Environmental Protection Agency (EPA). The Upriver Reach is the furthest upstream section of the Lower Willamette River which spans from RM 0.0 to 28.4. The Upriver Reach is narrow and swifter flowing compared to downstream reaches. The river bottom of the Lower Willamette River was evaluated in a Sediment Trend Analysis Report (GeoSea Consulting 2001) and identified a trend of harder to softer substrate surfaces from upstream to downstream reaches. Though the river bottom surface varies greatly throughout the Upriver Reach, this general trend exists with harder substrates in the upper portion between RMs 22 to 26, a marginal increase in sandy substrates between RMs 19 and 22, and a substantial increase in softer substrates, such as muddy sand and sandy mud, between RMs 16.6 and 19. Grain size analysis data from PDI samples in the vicinity of RM 16 and 19 indicate that sediments in the target sampling areas are finer grained with approximately 50 to 60 percent silts and clays with the remaining material being fine sands.

Land use along the Upriver Reach is predominantly residential with areas of mixed commercial and residential use. Industrial use is confined to a Lake Oswego industrial park located on the western riverbank between RM 20.0 and 20.5 and near Willamette Falls at approximately RM 26, where papermaking facilities historically have been located. For the proposed sample area from RM 16.0 to 16.5 East, land use along the eastern shoreline (downstream to upstream) is recreational (Oaks Amusement Park), park space (Sellwood Riverfront Park), and commercial office space (River Park Center). For the proposed sample area at RM 19.4 to 19.7 West, land use is residential with residences commonly containing private docks for recreational use. This area is also downstream of the confluence of Tryon Creek with the Willamette River at approximately RM 20.

2.2 Previous Investigation Activities

Previous investigations have been performed in the Upriver Reach to gather sediment, surface water, and tissue data for a variety of objectives. In 2017, historical data were reviewed along with environmental data on adjacent upland sites in preparation of a work plan to investigate potential contaminant sources within the Upriver Reach (DEQ 2017). The resulting Upriver Reach Sediment Characterization collected composite sediment samples from nine locations between RM 18.3 and 25.2 that primarily targeted confluences of other water bodies with the Willamette River or areas with wastewater treatment plants that discharged to the river. The results of this investigation indicated that with a few minor exceptions, contaminant concentrations were low (GSI and Hart Crowser 2018). One area of interest was identified on the east shore of RM 20 and follow-up samples were collected with the results indicating that no further action was warranted in that area.

To collect a current dataset on PHSS conditions, the Pre-RD AOC Group prepared and implemented a PDI Work Plan (Geosyntec Consultants, Inc. [Geosyntec] 2017). Surface sediment sampling protocols were outlined in a Surface Sediment Field Sampling Plan (AECOM and Geosyntec 2018). The PDI included grab samples from the upper foot of the sediment surface within the Upriver Reach. Chemical results were reported in the Pre-Remedial Design Footprint Report (AECOM and Geosyntec 2019). DEQ reviewed the PDI results and identified elevated concentrations of COIs in samples SG-B457 near RM 16.1, SG-B458 near

RM 16.3, and SG-B471 near RM 19.6 (Figures 2 and 3). The following lists the elevated COIs that were identified at each of these three locations.

- **SG-B457.** Total PCBs, DDx (the sum of dichlorodiphenyltrichloroethane [DDT] and its breakdown products DDD [dichlorodiphenyldichloroethane] and DDE [dichlorodiphenyldichloroethylene]), dioxins/furans toxic equivalency (TEQ), and benzo(a)pyrene TEQ.
- **SG-B458.** DDx and dioxins/furans TEQ.
- **SG-B471.** Total PCBs, dioxins/furans TEQ, and benzo(a)pyrene TEQ.

Further, fish tissue samples historically collected in the vicinity of RM 16 have contained elevated concentrations of PCBs.

2.3 Sediment Quality and Screening Levels

In 2017, EPA issued the ROD for the PHSS (EPA 2017). The ROD established CULs for contaminant of concern (COCs) in surface water, groundwater, riverbank soil/sediment, and fish tissue media. Due to the varying range of presence and concentrations of COCs found throughout the various media at PHSS, COCs that were the most widespread and posed the greatest risk were grouped together and called focused COCs. RALs were developed for focused COCs in sediment to identify areas were capping or dredging would be required to reduce COC concentrations. CULs and RALs developed for the PHSS may not be directly applicable to evaluate data collected in the Upriver Reach; however, the PHSS CULs and RALs will be compared with Upriver Reach data as part of a preliminary screening to inform next steps. In addition, data will be evaluated relative to DEQ Level II Ecological Screening Levels for freshwater sediment (DEQ 2001) as an initial step to evaluating potential toxicity to benthic invertebrates. Screening Levels are presented in Table 1.

3.0 SAMPLING AND ANALYTICAL APPROACH

Sediment sample locations were selected to: 1) collect data to delineate the extent of previously detected COI concentrations above CULs; and 2) collect data at suspected point sources for those exceedances. Samples from each location will consist of three discrete samples from a target depth of 0 to 30 centimeters (cm), or approximately 0 to 12 inches, that will be composited into a 3-point composite. Proposed sediment sample locations are shown on Figures 2 and 3. Samples will be analyzed for those COCs listed for sediment in Tables 17 and 21 of the PHSS ROD (EPA 2017) and also for PBDEs.

Sample SG-B457 (located between RM 16.0 and 16.1 East) and SG-B458 (located near RM 16.3 East) contained elevated concentrations of COIs. Sample SG-B456 (located near RM 15.9 West) did not contain elevated concentrations of COIs and provides bounding downstream of SG B457. Proposed sample location RM16.1-E-SED1 was selected to evaluate if elevated COIs are continuous in sediments between samples SG-B457 and SG-B457. Proposed sample location RM16.3-E-SED2 was selected upstream of SG-B458 to evaluate the extent of contamination. Sediment sample locations were also selected from the shoreline along this section of the river at locations where stormwater outfalls/ditches are located or may have historically been located to evaluate their potential as upland point sources and to provide data on

shoreline sediment quality. Utility records indicate that there are or once were three outfalls adjacent to Sellwood Riverfront Park and its paved parking lot. Proposed sediment samples RM16.3-E-SED3 through RM16.3-E-SED5 are located riverward of the three outfalls/ditches. The locations of the shoreline samples may be field adjusted in coordination with DEQ if other or additional potential source areas are identified.

Sample SG-B471 (located between RM 19.5 and 19.6) contained elevated concentrations of COIs with no other samples in the vicinity to provide bounding data. The location of SG-B471 is slightly upstream of an upland peninsula extending into the Willamette River, likely reducing flow velocity near the river's shoreline compared to the center channel of the river. Based on review of SG-B471 grain size data, the sediment in this area is composed of higher percent fines, likely the result of sediment deposition over time. Samples RM19.4-W-SED6 and RM19.6-W-SED8 were selected to evaluate the extent of contamination in both upstream and downstream directions. The RM19.5-W-SED7 location was selected to evaluate the extent of contamination further offshore.

The sample naming convention will consist of the RM location (to the nearest tenth of a mile) and side of the river (east or west) that the sample is collected on followed by the "SED" designation for sediment and a sequential sampling number. Should a sample location be adjusted in the field, the RM designation in the sample name will be adjusted to reflect the actual location of the collected sample.

4.0 SAMPLING ACTIVITIES

This section describes the sampling activities that will be implemented during this investigation. Field procedures may be modified based upon conditions encountered in the field. Field modifications will be discussed with the DEQ Project Manager prior to implementation and documented in the FDR.

4.1 Preparatory Activities

Prior to field work, we will perform the preparatory activities discussed below.

Permitting: No additional permitting is required for this investigation. Hart Crowser inquired with both permitting agencies, the U.S. Army Corps of Engineers (Corps) and the Oregon Department of State Lands (DSL) to verify that existing permits, obtained for the Upriver Reach Sediment Characterization and which have not expired, and are valid for this work. Sampling will be performed under Corps permit NWP-2017-440 and DSL permit 60662.

Health and Safety Plan. A site-specific Health and Safety Plan (HASP) will be prepared for the sampling activities in general accordance with the Occupational Safety and Health Act and the Oregon Administrative Rules. Sampling personnel will have a copy of the HASP for their use during field activities.

4.2 Sampling Vessel

A sampling vessel capable of navigating shallow waters and operating a power-grab sampler will be used for sediment sample collection. Sediment samples are located in close proximity to the riverbank and may have a shallow mudline depending on the river stage at the time of sampling. The sampling vessel will have a shallow draft, preferably 2.5 feet or less, to accommodate these sampling conditions. The sampling

vessel will also have an A-frame and winch capable of deploying a power-grab sampler. A captain experienced in positioning the vessel through the use of motors in addition to anchors and a crew experienced in the use of power-grab samplers will operate the vessel during sampling activities. The vessel should also be sufficiently powerful to navigate the Willamette River at a reasonable pace. The vessel should also be large enough to transport vessel crew, necessary equipment and supplies, and up to two field personnel to collect samples.

4.3 Station Locating

The vessel will be equipped with a differential global positioning system (GPS) capable of navigating to pre-determined locations and recording GPS coordinates to an accuracy of ± 1 meter (3.2 feet). Coordinates will be measured using the North American Datum of 1983 of the State Plane Coordinate System, Oregon North Zone. If difficulties are encountered with GPS coordinate collection, such as insufficient satellite coverage or obstructions (e.g., bridges or other vessels), an accuracy up to ± 2 meters (6.6 feet) may be allowed. The accuracy tolerances of coordinates and the nature of the condition affecting station location accuracy (if known) will be documented in a field logbook. Station information will be electronically recorded on the vessel's GPS device when the power-grab sampler is on the river bottom with redundant recordings in the field logbook by sample technicians or by a photograph of the GPS coordinate display.

For samples along the shoreline that are able to be collected using a hand-corer, GPS coordinates will be collected using a handheld GPS unit capable of decimeter accuracy. The elevation of the ground surface will be recorded using the GPS unit and surface water, if present in close enough proximity to the sample location to measure the difference in elevation between the river level and sample location, can be used to estimate the ground surface elevation as well.

Vertical positioning for sediment samples in water will be recorded using a lead line or fathomer while the power-grab sampler is on the river bottom. The water depth will be recorded to the nearest 0.1 feet and river stage data from U.S. Geological Survey Station 14211720 will be used. The station is located on the Morrison Street Bridge at RM 12.8. River stage data from this station is reported in National Geodetic Vertical Datum of 1929 (NGVD 29) with a gauge height of 0 feet equal to 1.55 feet NGVD 29. Mudline elevations will be converted to North American Vertical Datum of 1988 (NAVD 88) by adding a correction factor of 5.031 feet (1.55 feet to convert from gauge height to NGVD 29 plus 3.481 feet to convert from NGVD 29 to NAVD 88). Shoreline sample elevations using a handheld GPS unit will be measured directly in NAVD 88.

4.4 Sample Collection

Samples will be collected using one of two methods: a power-grab sampler for river bottom sediment samples, and if possible (based on tidal stage and seasonal river stage) a hand corer for sediment samples on the shoreline. The following sections discuss each sampling method.

4.4.1 Power-Grab Sampling on Vessel

The captain will navigate the vessel to the pre-determined sampling location and station the vessel for sampling. The power-grab sampler (similar to a Van-Veen sampler but hydraulically powered to achieve deeper sediment penetration) will be affixed to a winch line and slowly lowered to minimize disturbance

to the sediment surface. Once the power-grab sampler is resting on the sediment surface, the jaws of the sampler will be actuated to collect sample material. The sampler will target the top 30 cm of the sediment surface. Once deployed, the sampler will be retrieved and placed on a table on the vessel deck to assess acceptability. Acceptability of each discrete grab sample will be based on the following criteria.

- Minimal or no excess water leaking from the jaws of the sampler
- Sampler didn't over-penetrate the sediment surface
- Sediment surface is intact or has minimal disturbance
- Excessive turbidity not present in water overlaying sediment in the sampler

Based on past sampling efforts completed in the Upriver Reach, limited sediment and/or rocky substrates may be present at sample locations limiting the depth of penetration. If such conditions are encountered, a minimum penetration depth of 20 cm will be considered acceptable.

Once a discrete sample has been deemed acceptable, sediment will be obtained using a stainless-steel spoon from the full depth of the sampler and avoiding sediments in contact with the sides of the sampler. Sediment will be transferred to a stainless-steel bowl for sample processing. The vessel will then shift 5 feet and proceed with collection of the next discrete sample. Discrete grab samples will be collected until approximately equal volumes of material have been collected from three spots at each sample location. Sediment samples will be processed according to procedures detailed in Section 4.5.

If the minimum penetration depth isn't achieved at a sample location, the vessel will move approximately 5 to 10 feet within a 25-foot radius of the original sample location and sample collection will be reattempted. If three attempts to collect acceptable discrete samples are unsuccessful, sample collection will be reattempted within a 50-foot radius of the original sample location. If sample collection attempts remain unsuccessful, Hart Crowser/GSI will confer with DEQ to identify if another target location should be attempted.

4.4.2 Manual Grab Sampling Along Shoreline

Shoreline sediment samples will be collected from the tidal flats near three current or historical stormwater outfalls/ditches adjacent to Sellwood Riverfront Park. Sampling personnel will locate the target outfall/ditch along the riverbank and select a location on the shoreline immediately downslope of the outfall/ditch to manually advance the hand corer sediment sampler. The hand corer will be of stainless-steel construction, a minimum of 1.5 inches in diameter, and a minimum of 2 feet in length. The hand corer will use high density polyethylene plastic liners and sediment catcher liner inserts (as needed) to contain sediment within the core barrel. The hand corer will be advanced to a target depth of 30 cm. The hand corer will then be retrieved and the acceptability of each sediment core will be determined. Acceptability will be assessed using the following criteria.

- Not overfilling the sampler
- Achieving a minimum of 20 cm penetration depth

- Observing no evidence of sediment loss
- Advancing the sampler without obstruction or blocking of its mouth

Once the sediment core has been deemed acceptable for use, the sediment will be extruded from the core and placed into a stainless-steel bowl for processing. Subsequent cores will be collected within 2 feet of the original sample location until three sediment cores and sufficient sample volume has been collected. If rocks or obstructions are encountered and prevent sample collection using the hand corer, then a spade shovel will be used to collect sediment, and gravel-sized rocks or debris will be removed from material collected on the shovel. The depth of penetration will be measured on the shovel in order to target material from the top 30 cm of the sediment surface. Shoreline sediment samples will be processed as detailed in Section 4.5.

4.4.3 Field Quality Control Samples

Field QC samples are used to assess the effectiveness of sampling protocols, decontamination procedures, and assess for cross-contamination or outside contamination of samples or sampling supplies. The following discusses field QC samples. Analytical QA/QC procedures are discussed further in Section 5.

Field Duplicate. A field duplicate sample, also known as a field split, is the collection of a secondary sample from the same sample material. A field duplicate is a field collected sample submitted to the laboratory to assess the precision of laboratory equipment. A field duplicate will also assess the effectiveness of homogenization for composite samples. Once each composite sample has been homogenized, the primary sample and the field duplicate will be collected from the homogenized material. Field duplicates will be collected at a rate of 1 per 20 samples collected, or 5 percent. As eight samples are proposed for this investigation, one field duplicate will be collected.

Rinsate Blank. A rinsate blank, also known as an equipment blank, will be collected from a piece of reusable sampling equipment to evaluate the effectiveness of decontamination activities. The rinsate blank will be collected by pouring distilled or deionized water over a decontaminated piece of sampling equipment and capturing the water into a sample container for laboratory analysis for site COIs. The absence of COIs in the rinsate sample results will verify that decontamination procedures and implementation were performed properly. Rinsate blanks will be collected at the same rate as field duplicates. One rinsate blank will be collected during this investigation.

Other Blanks. A temperature blank will be included in each sample cooler to measure cooler temperature upon arrival at the laboratory to verify that samples were kept at the required temperature of 6°C or below. Trip blanks and field blanks are not required because samples will not be analyzed for volatile organic compounds (VOCs).

4.4.4 Field Documentation

As samples are collected, field notes of sediment sampling activities and observations will be maintained in a project notebook. Observations that will be recorded will include:

- Date, time, and river stage;
- Weather conditions;
- Water depth;
- Sampling location, number of attempts, and recovery;
- Sediment characteristics (odor; sheen; presence of wood or other debris; staining; color; grain size; relative proportions of fines, sand, and gravel; and soil classification in accordance with visual-manual classification methods of ASTM D 2488); and
- Photograph of each sediment sample and location (if not underwater).

In addition to the items listed above, field documentation will include any deviations from this Work Plan.

4.5 Sample Processing and Handling

Sample processing includes a description of sediment characteristics, homogenization, and composite sample collection, and will be performed onboard the sample vessel for power-grab samples and onshore for manual grab samples.

Sample processing will begin with homogenization of sediment from each discrete sample from a given sampling location. Equal volumes of homogenized material from each discrete sample will be transferred to another stainless-steel bowl and manually mixed using a stainless-steel spoon. Material will be mixed until a uniform color and consistency is achieved and for no less than 60 seconds. Once homogenized, any additional sediment characteristics will be recorded on field forms or in the project notebook. A composite sample will be collected and placed into the appropriate laboratory-supplied sample containers. Remaining homogenized sample material will be placed in a sample container and submitted as an archive sample.

Sample containers will be labeled, and sample information will be recorded onto a chain of custody form. Samples containers will be placed into resealable plastic bags, packaged for transport, placed into a cooler on ice, and transferred to a laboratory and/or overnight courier for delivery to the analytical laboratories. Chain of custody documentation will be maintained at all times.

4.6 Decontamination

Decontamination of the power-grab sampler and hand corer will be performed before sample collection and between sample locations. The power-grab sampler and hand corer will be rinsed with river water to remove excess sediment but will not be decontaminated between collection of discrete samples within a given sample location. The following decontamination procedures will be used:

- River water will be used to rinse equipment and remove bulk sediment from the sampler. Brushes may be used to aid removal of sediment;
- Surfaces of equipment contacting sediment will be scrubbed with brushes using a biodegradable, phosphate free detergent solution (e.g., Liquinox™);

- Scrubbed equipment will be rinsed and scrubbed with clean tap water; and
- Equipment will undergo a final rinse with distilled or deionized water.

Final rinses with nitric acid or methanol are not anticipated to be required but may be performed if oil or tar residue debris is encountered.

All hand work will be conducted using disposable nitrile gloves, which will be replaced between sampling locations to prevent cross contamination. The workspace for processing samples will be covered with aluminum foil or plastic sheeting dedicated only to processing material from one sample location.

All other non-disposable sampling equipment (e.g., stainless steel bowls and sampling spoons) will be cleaned before and between each sample location using the procedures described above. Sampling spoons and bowls will be covered with aluminum foil until use. We will collect an equipment rinsate blank for analysis for organic contaminants to evaluate the effectiveness of equipment decontamination (see Section 4.4.3).

4.7 Investigation-Derived Waste Management

Investigation-derived waste will consist of excess sediment or water during sampling disposable sampling supplies, and used personal protective equipment (PPE). Any excess water or sediment remaining after processing will normally be returned to the river in the vicinity of the collection site. If generated, nitric acid or methanol solutions will be containerized in a 5-gallon bucket on board the vessel and transferred to a 55-gallon drum onshore for proper disposal. Used sampling supplies (e.g., gloves, foil, plastic sheeting, and plastic core liners) and PPE will be collected into a plastic trash bag and disposed of as municipal solid waste in the trash dumpster at the Hart Crowser office. Decontamination water from processing activities will be disposed of in the municipal sanitary sewer.

5.0 ANALYTICAL AND QA/QC PROGRAM

We will submit sediment samples under chain of custody documentation to analytical laboratories for chemical analysis. Most analyses will be performed by Pace Analytical National of Mt. Juliet, Tennessee, under State Price Agreement #8903. ALS Environmental in Burlington, Ontario, Canada, will be used to conduct analyses for total solids, dioxin/furans, organochlorine pesticides, PDBEs, and PCB congeners. All laboratories are accredited by the Oregon Environmental Laboratory Accreditation Program and/or through an accreditation body under the National Environmental Laboratory Accreditation Program. Testing will be performed on a standard turnaround time, usually 10 to 20 business days.

5.1 Analytical Methods

Table 1 presents the analyses to be performed, their analytical methods, PHSS CULs and RALs and DEQ Level II Ecological SLVs for sediment, method detection limits (MDLs) and sample quantification limits (SQLs). Sediment samples will be analyzed for COIs and physical parameters by the analytical methods listed below.

- Total organic carbon by Puget Sound Estuary Protocols (PSEP) 1986.
- Total solids by PSEP 1986.
- Grain size distribution by American Society for Testing and Materials (ASTM) Method D422.
- Metals by EPA Method 6020B.
- Mercury by EPA Method 7471B.
- TPHd by Northwest Method NWTPH-Dx.
- Dioxins/furans by EPA Method 1613B.
- Organochlorine pesticides by EPA Method 1669M.
- SVOCs, including PAHs and select phenols and phthalates, by EPA Method 8270D-SIM.
- PBDEs by EPA Method 8270 or 1614.
- PCB congeners by EPA Method 1668B.

Tributyltin is a COC for PHSS but is not included for analysis in this investigation as it is typically found in locations where ship maintenance is performed. As no ship maintenance activities were performed or identified in the Upriver Reach, tributyltin analysis will not be performed.

5.2 Quality Assurance/Quality Control

Sediment samples will be collected and analyzed in accordance with DEQ's QAPP (DEQ 2012). This QAPP presents quality objectives and procedures for sampling and analysis which are summarized below. The general QA objectives for this project are to develop and implement procedures for obtaining and evaluating data of a specified quality that can be used to determine current sediment quality, assess the extent of COI impacts, and be used to evaluate risks posed to human health and the environment. To collect such information, analytical data must have an appropriate degree of accuracy and reproducibility, samples collected must be representative of actual field conditions, and samples must be collected and analyzed using unbroken chain of custody procedures.

Field QA/QC. Adherence to the field and decontamination procedures described in Section 4 will minimize the potential for contamination of sediment samples. A rinsate blank will also be collected during the field activities. The rinsate blank is prepared by pouring laboratory-supplied, analyte-free water over decontaminated sampling equipment (i.e., power-grab sampler or hand corer) and collecting it in sample containers. The blank will assess the effectiveness of decontamination activities. The blank will be submitted to the laboratory and analyzed for the COIs. Analysis for VOCs will not be performed as part of investigation sampling activities, eliminating the need for a trip blank or field blank. One field duplicate will be collected and analyzed to assess analytical precision.

Chain of Custody. A chain of custody record for the samples will be maintained during sample handling and transport and will accompany sample shipments to the analytical laboratory. The chain of custody information that will continue to be tracked at the analytical laboratory includes: sample identification

number; date and time of sample receipt; analytical parameters; location and conditions of storage; date and time of removal from and return to storage; signature of person removing and returning the sample; reason for removing from storage; and final disposition of the samples.

Sample Quantitation Limits. Sediment samples will be analyzed according to the test methods identified in Table 1. Sample quantitation limits (SQLs) for these test methods are listed in Table 1 and are lower than the SLVs; however, if SQLs cannot meet these criteria, the MDL will be reported. The analytical program and listed reporting limits will generate appropriate and useable data, achieve data quality objectives, and support management decisions.

Sample Storage Requirements. Samples for chemical testing will be maintained at the testing laboratory in accordance with the sample holding limitations and storage requirements listed in Table 2. Archive samples will be stored for a minimum of 6 months and approval will be required from Hart Crowser prior to sample disposal. Samples will be maintained under proper storage conditions until the chemistry data are deemed acceptable by the review agencies.

Laboratory QA/QC Samples. Method blanks, matrix spikes, surrogates (organic constituents only), laboratory control samples, and duplicates will be performed by the laboratory in accordance with the method specifications and as listed in Table A7-1 of the DEQ QAPP (DEQ 2012).

Laboratory Report. A written report will be prepared by the laboratories documenting the following items associated with the analysis of project samples:

- Field and laboratory sample identification number, sample date, the date it was received at the laboratory, and the dates that it was extracted and analyzed.
- The quantified concentration (if present), MDL, SQL, and concentration units for each analyte.
- Laboratory QC sample results (including date and time of analysis, method, and acceptability criteria).
- Data qualifiers assigned by the laboratory, with definitions for each qualifier used.
- Chain of custody documentation and sample receipt forms, including description of deviations.
- A case narrative of any protocol deviations.

Independent Data Quality Review. Hart Crowser will perform an independent data quality review of the chemical analytical results provided by the laboratories. This report will assess the adequacy of the MDLs and SQLs in achieving applicable SLVs; the precision, accuracy, representativeness, comparability, and completeness of the data; and the usability of the analytical data for project objectives. Exceedances of analytical control limits will be summarized and evaluated. The data quality review will be incorporated into the FDR described in Section 7.

6.0 DATA MANAGEMENT

Field activities and observations will be recorded on field log sheets throughout each sampling day and sampling information will be recorded on sample collection logs at the time of sampling. Sample and

sample possession information will be recorded on a chain of custody form at the time of sample collection until sample receipt by the analytical laboratory. All field documentation will be scanned and uploaded to the project folder on the Hart Crowser server and hard copies will be filed in a project folder. Electronic data, such as digital photographs and GPS coordinate data, will be uploaded to the project file on the Hart Crowser server.

Analytical results will be provided by the laboratory in PDF form and as an electronic data deliverable (EDD) in tabulated form. A QA review will be performed on the analytical results and laboratory QA/QC procedures. Analytical results that are qualified as part of the QA review will be incorporated into the EDD and provided to DEQ for inclusion in project files.

As analytical results will be compared to CULs and RALs for PHSS, data summation will be performed for select analytical groups in accordance with rules established in the PHSS Remedial Investigation/Feasibility Study (EPA 2016). Data summation will be performed using two methods for non-detect concentrations: zero for MDL value and the more conservative risk assessment/background data rules which use one half the MDL value. The following data summation rules will be used:

- Totals will be calculated by summing only detected concentrations and by summing all detected concentrations plus one half the MDL value for non-detected results.
- If all analytes were not detected, the highest MDL value will be used for the summation total.
- Data qualifiers will be carried through the summation calculation. Summed totals will be flagged with a "T" qualifier indicating they are mathematically calculated totals.

Additional data summation rules will be used for PHSS for these analytical groups per EPA (2016): total dioxin/furans; dioxin/furan TEQ (Van den Berg, et al. 2006); total DDD, DDE, DDT, and DDx; total chlordanes; total low and high molecular weight PAHs; total carcinogenic PAHs as a benzo(a)pyrene equivalents (EPA 1993); and total PCBs.

7.0 PROJECT SCHEDULE AND REPORTING

Field activities described within this Work Plan are planned to be implemented by October 31, 2019, and reporting to be completed by December 31, 2019.

After receipt of analytical results, we will prepare an FDR documenting field activities and presenting analytical results. The FDR will present project organizational information, sampling approach, description of field activities, laboratory analytical and QC/QC activities, and sediment analytical results according to the outline below.

1. Introduction
2. Project Organization
3. Setting and Sampling Approach
4. Field Activities
5. Laboratory Analysis and QA/QC

6. Electronic Data Management
7. Sediment Analytical Results
8. References

   Appendices:

   Field Documentation

   Laboratory Analytical Report, including QA review

Data summary tables with COI concentrations compared to the SLVs will be included, as well as figures presenting pertinent sediment data. The report will initially be prepared as a draft for review by the DEQ. Upon receipt of DEQ's comments, we will issue the report in final form.

8.0 REFERENCES

AECOM and Geosyntec 2018. Surface Sediment Field Sampling Plan, Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling, Portland Harbor Superfund Site. March 29, 2018.

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DEQ 2001. Guidance for Ecological Risk Assessment. Level II – Screening. December 2001.

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DEQ 2017. Work Plan Upriver Reach Sediment Characterization Lower Willamette River Portland, Oregon. October 2017.

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Geosyntec Consultants, Inc. (Geosyntec) 2017. Final Work Plan, Portland Harbor Pre-Remedial Design Investigation Studies, Portland Harbor Superfund Site, Portland, Oregon. December 19, 2017.

GSI and Hart Crowser 2018. Final Field and Data Report Upriver Reach Sediment Characterization Lower Willamette River Portland, Oregon. May 8, 2018.

Van den Berg, M., L.S. Birnbaum, M. Denison, M. De Vito, W. Farland, M. Freeley, H. Fiedler, H. Hakansson, A. Hanberg, L. Haws, M. Rose, S. Safe, D. Schrenk, C. Tohyama, A. Tritscher, J. Tuomisto, M. Tysklind, N. Walker, and R.E. Peterson. 2006. The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicological Sciences 93(2), 223-241.

TABLES

Table 1 - Analytes, Analytical Methods, Screening Criteria, and Reporting Limit Goals
Upriver Reach, Lower Willamette River
Portland, Oregon

Analyte	Unit[a]	Analytical Method	PHSS[b] CUL	PHSS[b] RAL	DEQ Level II Eco SLVs[b]	Typical Values[c] MDL	Typical Values[c] SQL
Conventionals							
Total Organic Carbon	%	PSEP	--	--	--	0.07	0.2
Total Solids	%	PSEP	--	--	--	NA	NA
Grain Size Distribution	%	ASTM D422	--	--	--	NA	NA
Metals							
Arsenic	mg/kg	EPA 6020B	3	--	6	0.2	0.5
Cadmium	mg/kg	EPA 6020B	0.51	--	0.6	0.009	0.02
Chromium	mg/kg	EPA 6020B	--	--	37	0.07	0.2
Copper	mg/kg	EPA 6020B	359	--	36	0.04	0.1
Lead	mg/kg	EPA 6020B	196	--	35	0.02	0.05
Manganese	mg/kg	EPA 6020B	--	--	1,100	0.02	0.05
Mercury	mg/kg	EPA 7471B	0.085	--	0.2	0.002	0.02
Nickel	mg/kg	EPA 6020B	--	--	18	0.04	0.2
Zinc	mg/kg	EPA 6020B	459	--	123	0.2	0.5
Total Petroleum Hydrocarbons							
Diesel-Range Hydrocarbons (with Silica Gel Clean-up)	mg/kg	NWTPH-Dx	91	--	--	1.6	25
Dioxins/Furans (Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans)							
1,2,3,4,6,7,8-HpCDD	µg/kg	EPA 1613B	--	--	--	0.00007	0.0005
1,2,3,4,6,7,8-HpCDF	µg/kg	EPA 1613B	--	--	--	0.00005	0.0005
1,2,3,4,7,8,9-HpCDF	µg/kg	EPA 1613B	--	--	--	0.00003	0.0005
1,2,3,4,7,8-HxCDD	µg/kg	EPA 1613B	--	--	--	0.00004	0.0005
1,2,3,4,7,8-HxCDF	µg/kg	EPA 1613B	0.0004	--	--	0.00004	0.0005
1,2,3,6,7,8-HxCDD	µg/kg	EPA 1613B	--	--	--	0.00004	0.0005
1,2,3,6,7,8-HxCDF	µg/kg	EPA 1613B	--	--	--	0.00004	0.0005
1,2,3,7,8,9-HxCDD	µg/kg	EPA 1613B	--	--	--	0.00004	0.0005
1,2,3,7,8,9-HxCDF	µg/kg	EPA 1613B	--	--	--	0.00004	0.0005
1,2,3,7,8-PeCDD	µg/kg	EPA 1613B	0.0002	0.0008	--	0.00004	0.0005
1,2,3,7,8-PeCDF	µg/kg	EPA 1613B	--	--	--	0.00005	0.0005
2,3,4,6,7,8-HxCDF	µg/kg	EPA 1613B	--	--	--	0.00004	0.0005
2,3,4,7,8-PeCDF	µg/kg	EPA 1613B	0.0003	0.2	--	0.00003	0.0005
2,3,7,8-TCDD	µg/kg	EPA 1613B	0.0002	0.0006	0.009	0.00004	0.0001
2,3,7,8-TCDF	µg/kg	EPA 1613B	0.0004	--	--	0.00002	0.0001
Dioxin/Furan TEQ (2,3,7,8-TCDD Eq)	µg/kg	EPA 1613B	0.01	--	--	0.0001	0.001
Total Dioxins/Furans	µg/kg	EPA 1613B	--	--	--	0.0005	0.005
Pesticides							
2,4'-DDD	µg/kg	EPA 1699M	--	--	--	0.14	0.2
2,4'-DDE	µg/kg	EPA 1699M	--	--	--	0.06	0.2
2,4'-DDT	µg/kg	EPA 1699M	--	--	--	0.17	0.2
4,4'-DDD	µg/kg	EPA 1699M	--	--	--	0.06	0.2
4,4'-DDE	µg/kg	EPA 1699M	--	--	--	0.03	0.2
4,4'-DDT	µg/kg	EPA 1699M	--	--	--	0.04	0.2
Total DDD	µg/kg	EPA 1699M	114	--	4	0.20	0.2
Total DDE	µg/kg	EPA 1699M	226	--	1.5	0.09	0.2
Total DDT	µg/kg	EPA 1699M	246	--	4	0.21	0.2
Total DDx	µg/kg	EPA 1699M	6.1	160	7	0.50	0.2
cis-Chlordane	µg/kg	EPA 1699M	--	--	--	0.02	0.2
cis-Nonachlor	µg/kg	EPA 1699M	--	--	--	0.08	0.2
Oxychlordane	µg/kg	EPA 1699M	--	--	--	0.01	0.2
trans-Chlordane	µg/kg	EPA 1699M	--	--	--	0.04	0.2
trans-Nonachlor	µg/kg	EPA 1699M	--	--	--	0.05	0.2
Total Chlordanes	µg/kg	EPA 1699M	1.4	--	4.5	0.20	0.2

Please refer to notes on the last page of this table.

Table 1 - Analytes, Analytical Methods, Screening Criteria, and Reporting Limit Goals
Upriver Reach, Lower Willamette River
Portland, Oregon

Analyte	Unit[a]	Analytical Method	PHSS[b]		DEQ Level II	Typical Values[c]	
			CUL	RAL	Eco SLVs[b]	MDL	SQL
Pesticides (Continued)							
Aldrin	µg/kg	EPA 1699M	2	--	40	0.05	0.2
alpha-BHC	µg/kg	EPA 1699M	--	--	--	0.02	0.2
beta-BHC	µg/kg	EPA 1699M	--	--	--	0.14	0.2
delta-BHC	µg/kg	EPA 1699M	--	--	--	0.14	0.2
Chlorpyrifos	µg/kg	EPA 1699M	--	--	--	0.11	0.2
Dieldrin	µg/kg	EPA 1699M	0.07	--	3	0.04	0.2
Endosulfan I	µg/kg	EPA 1699M	--	--	--	0.08	0.2
Endosulfan II	µg/kg	EPA 1699M	--	--	--	0.04	0.2
Endosulfan Sulfate	µg/kg	EPA 1699M	--	--	--	0.05	0.2
Endrin	µg/kg	EPA 1699M	--	--	3	0.03	0.2
Endrin Aldehyde	µg/kg	EPA 1699M	--	--	--	0.06	0.2
Endrin Ketone	µg/kg	EPA 1699M	--	--	--	0.16	0.2
Gamma-HCH (Lindane)	µg/kg	EPA 1699M	5	--	0.9	0.03	0.2
Heptachlor	µg/kg	EPA 1699M	--	--	10	0.03	0.2
Heptachlor Epoxide	µg/kg	EPA 1699M	--	--	0.6	0.02	0.2
Hexachlorobenzene	µg/kg	EPA 1699M	--	--	100	0.03	0.2
Isodrin	µg/kg	EPA 1699M	--	--	--	0.2	0.2
Methoxychlor	µg/kg	EPA 1699M	--	--	--	0.03	0.2
Mirex	µg/kg	EPA 1699M	--	--	800	0.06	0.2
Octachlorostyrene	µg/kg	EPA 1699M	--	--	--	0.01	0.2
Polycyclic Aromatic Hydrocarbons (PAHs)							
2-Methylnaphthalene	µg/kg	EPA 8270D	--	--	--	2	6
Acenaphthene	µg/kg	EPA 8270D	--	--	290	0.6	6
Acenaphthylene	µg/kg	EPA 8270D	--	--	160	0.6	6
Anthracene	µg/kg	EPA 8270D	--	--	57	0.6	6
Benzo(a)anthracene	µg/kg	EPA 8270D	--	--	32	0.6	6
Benzo(a)pyrene	µg/kg	EPA 8270D	--	--	32	0.6	6
Benzo(b)fluoranthene	µg/kg	EPA 8270D	--	--	--	0.6	6
Benzo(g,h,i)perylene	µg/kg	EPA 8270D	--	--	300	0.6	6
Benzo(k)fluoranthene	µg/kg	EPA 8270D	--	--	27	0.6	6
Chrysene	µg/kg	EPA 8270D	--	--	57	0.6	6
Dibenzo(a,h)anthracene	µg/kg	EPA 8270D	--	--	33	0.6	6
Fluoranthene	µg/kg	EPA 8270D	--	--	111	0.6	6
Fluorene	µg/kg	EPA 8270D	--	--	77	0.6	6
Indeno(1,2,3-cd)pyrene	µg/kg	EPA 8270D	--	--	17	0.6	6
Naphthalene	µg/kg	EPA 8270D	--	--	176	2	6
Phenanthrene	µg/kg	EPA 8270D	--	--	42	0.6	6
Pyrene	µg/kg	EPA 8270D	--	--	53	0.6	6
Total PAH	µg/kg	EPA 8270D	23,000	13,000	1,610	--	--
Total cPAH (BaP Eq)	µg/kg	EPA 8270D	85[d]	--	193	--	--
Phenols							
Pentachlorophenol	µg/kg	EPA 8270D	--	--	--	5.3	100
Phthalates							
Bis(2-Ethylhexyl) Phthalate	µg/kg	EPA 8270D	135	--	750	8.9	100
Polybrominated Diphenyl Ethers (PBDEs)							
PBDE 17	µg/kg	EPA 8270D or 1614	--	--	--	0.0005	0.003
PBDE 28	µg/kg	EPA 8270D or 1614	--	--	--	0.0005	0.003
PBDE 47	µg/kg	EPA 8270D or 1614	--	--	--	0.0010	0.003
PBDE 66	µg/kg	EPA 8270D or 1614	--	--	--	0.0003	0.003
PBDE 71	µg/kg	EPA 8270D or 1614	--	--	--	0.0002	0.003
PBDE 85	µg/kg	EPA 8270D or 1614	--	--	--	0.0002	0.004

Please refer to notes on the last page of this table.

Table 1 - Analytes, Analytical Methods, Screening Criteria, and Reporting Limit Goals
Upriver Reach, Lower Willamette River
Portland, Oregon

Analyte	Unit[a]	Analytical Method	PHSS[b]		DEQ Level II	Typical Values[c]	
			CUL	RAL	Eco SLVs[b]	MDL	SQL
PBDEs (Continued)							
PBDE 99	µg/kg	EPA 8270D or 1614	--	--	--	0.0030	0.004
PBDE 100	µg/kg	EPA 8270D or 1614	--	--	--	0.0007	0.004
PBDE 128	µg/kg	EPA 8270D or 1614	--	--	--	0.0009	0.004
PBDE 138	µg/kg	EPA 8270D or 1614	--	--	--	0.0013	0.004
PBDE 153	µg/kg	EPA 8270D or 1614	--	--	--	0.0004	0.005
PBDE 154	µg/kg	EPA 8270D or 1614	--	--	--	0.0007	0.005
PBDE 183	µg/kg	EPA 8270D or 1614	--	--	--	0.0005	0.006
PBDE 190	µg/kg	EPA 8270D or 1614	--	--	--	0.0010	0.006
PBDE 203	µg/kg	EPA 8270D or 1614	--	--	--	0.0003	0.006
PBDE 206	µg/kg	EPA 8270D or 1614	--	--	--	0.0014	0.013
PBDE 209	µg/kg	EPA 8270D or 1614	--	--	--	0.0061	0.025
Polychlorinated Biphenyl (PCB) Congeners							
2-MonoCB-(1)	µg/kg	EPA 1668B	--	--	--	0.0006	0.003
3-MonoCB-(2)	µg/kg	EPA 1668B	--	--	--	0.0006	0.003
4-MonoCB-(3)	µg/kg	EPA 1668B	--	--	--	0.0006	0.003
22'-DiCB-(4)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
2,3-DiCB-(5)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
2,3'-DiCB-(6)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
2,4-DiCB-(7)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
2,4'-DiCB-(8)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
2,5-DiCB-(9)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
2,6-DiCB-(10)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
3,3'-DiCB-(11)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
DiCB-(12)+(13)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
3,5-DiCB-(14)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
4,4'-DiCB-(15)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'3-TriCB-(16)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'4-TriCB-(17)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
TriCB-(18)+(30)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'6-TriCB-(19)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
TriCB-(20) + (28)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
TriCB-(21)+(33)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
234'-TriCB-(22)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
235-TriCB-(23)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
236-TriCB-(24)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
23'4-TriCB-(25)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
TriCB-(26)+(29)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
23'6-TriCB-(27)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
24'5-TriCB-(31)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
24'6-TriCB-(32)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
23'5'-TriCB-(34)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
33'4-TriCB-(35)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
33'5-TriCB-(36)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
344'-TriCB-(37)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
345-TriCB-(38)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
34'5-TriCB-(39)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
TetraCB-(40)+(41)+(71)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'34'-TetraCB-(42)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'35-TetraCB-(43)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
TetraCB-(44)+(47)+(65)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
TetraCB-(45)+(51)	µg/kg	EPA 1668B	--	--	--	0.001	0.003

Please refer to notes on the last page of this table.

Table 1 - Analytes, Analytical Methods, Screening Criteria, and Reporting Limit Goals
Upriver Reach, Lower Willamette River
Portland, Oregon

Analyte	Unit[a]	Analytical Method	PHSS[b] CUL	PHSS[b] RAL	DEQ Level II Eco SLVs[b]	Typical Values[c] MDL	Typical Values[c] SQL
PCB Congeners (Continued)							
22'36'-TetraCB-(46)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'45-TetraCB-(48)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
TetraCB-(49)+TetraCB-(69)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
TetraCB-(50)+(53)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'55'-TetraCB-(52)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'66'-TetraCB-(54)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'4-TetraCB-(55)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'4'-Tetra CB(56)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'5-TetraCB-(57)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'5'-TetraCB-(58)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
TetraCB-(59)+(62)+(75)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
2344'-TetraCB -(60)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
TetraCB-(61)+(70)+(74)+(76)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
234'5-TetraCB-(63)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
234'6-TetraCB-(64)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
23'44'-TetraCB-(66)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
23'45-TetraCB-(67)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
23'45'-TetraCB-(68)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
23'55'-TetraCB-(72)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
23'5'6-TetraCB-(73)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
33'44'-TetraCB-(77)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
33'45-TetraCB-(78)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
33'45'-TetraCB(79)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
33'55'-TetraCB-(80)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
344'5-TetraCB-(81)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'4-PentaCB-(82)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
PentaCB-(83)+(99)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'6-PentaCB-(84)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
PentaCB-(85)+(116)+(117)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
PentaCB-(86)(87)(97)(109)(119)(125)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
PentaCB-(88)+(91)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'346'-PentaCB-(89)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
PentaCB-(90)+(101)+(113)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'355'-PentaCB-(92)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
PentaCB-(93)+(98)+(100)+(102)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'356'-PentaCB-(94)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'35'6-PentaCB-(95)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'366'-PentaCB-(96)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'45'6-PentaCB-(103)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'466'-PentaCB-(104)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'44'-PentaCB-(105)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'45-PentaCB-(106)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'4'5-PentaCB-(107)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
PentaCB-(108)+(124)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
PentaCB-(110)+(115)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'55'-PentaCB-(111)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'56-PentaCB-(112)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
2344'5-PentaCB-(114)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
23'44'5-PentaCB-(118)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
23'455'-PentaCB-(120)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
23'45'6-PentaCB-(121)	µg/kg	EPA 1668B	--	--	--	0.001	0.003

Please refer to notes on the last page of this table.

Table 1 - Analytes, Analytical Methods, Screening Criteria, and Reporting Limit Goals
Upriver Reach, Lower Willamette River
Portland, Oregon

Analyte	Unit[a]	Analytical Method	PHSS[b] CUL	PHSS[b] RAL	DEQ Level II Eco SLVs[b]	Typical Values[c] MDL	Typical Values[c] SQL
PCB Congeners (Continued)							
233'4'5'-PentaCB-(122)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
23'44'5'-PentaCB-(123)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
33'44'5-PentaCB-(126)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
33'455'-PentaCB-(127)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
HexaCB-(128)+(166)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
HexaCB-(129)+(138)+(163)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'45'-HexaCB-(130)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'46-HexaCB-(131)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'46'-HexaCB-(132)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'55'-HexaCB-(133)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
HexaCB-(134)+(143)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
HexaCB-(135)+(151)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'66'-HexaCB-(136)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'344'5-HexaCB-(137)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
HexaCB-(139)+(140)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'3455'-HexaCB-(141)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'3456-HexaCB-(142)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'345'6-HexaCB-(144)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'3466'-HexaCB-(145)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'34'55'-HexaCB-(146)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
HexaCB-(147)+(149)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'34'56'-HexaCB-(148)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'34'66'-HexaCB-(150)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'3566'-HexaCB-(152)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
HexaCB-(153)+(168)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'44'56'-HexaCB-(154)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'44'66'-HexaCB-(155)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
HexaCB-(156)+(157)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'44'6-HexaCB-(158)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'455'-HexaCB-(159)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'456-HexaCB-(160)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'45'6-HexaCB-(161)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'4'55'-HexaCB-(162)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'4'5'6-HexaCB-(164)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'55'6-HexaCB-(165)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
23'44'55'-HexaCB-(167)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
33'44'55'-HexaCB-(169)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'44'5-HeptaCB-(170)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
HeptaCB-(171)+(173)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'455'-HeptaCB-(172)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'456'-HeptaCB-(174)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'45'6-HeptaCB-(175)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'466'-HeptaCB-(176)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'45'6'-HeptaCB-(177)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'55'6-HeptaCB-(178)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'566'-HeptaCB-(179)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
HeptaCB-(180)+(193)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'344'56-HeptaCB-(181)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'344'56'-HeptaCB-(182)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'344'5'6-HeptaCB-(183)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'344'66'-HeptaCB-(184)	µg/kg	EPA 1668B	--	--	--	0.001	0.003

Please refer to notes on the last page of this table.

Table 1 - Analytes, Analytical Methods, Screening Criteria, and Reporting Limit Goals
Upriver Reach, Lower Willamette River
Portland, Oregon

Analyte	Unit[a]	Analytical Method	PHSS[b] CUL	PHSS[b] RAL	DEQ Level II Eco SLVs[b]	Typical Values[c] MDL	Typical Values[c] SQL
PCB Congeners (Continued)							
22'3455'6-HeptaCB-(185)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'34566'-HeptaCB-(186)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'34'55'6-HeptaCB-(187)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'34'566'-HeptaCB-(188)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'44'55'-HeptaCB-(189)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'44'56-HeptaCB-(190)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'44'5'6-HeptaCB-(191)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'455'6-HeptaCB-(192)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'44'55'-OctaCB-(194)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'44'56-OctaCB-(195)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'44'56'-OctaCB-(196)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'44'66'OctaCB-(197)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
OctaCB-(198)+(199)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'4566'-OctaCB-(200)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'45'66'-OctaCB-(201)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'55'66'-OctaCB-(202)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'344'55'6-OctaCB-(203)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'344'566'-OctaCB-(204)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
233'44'55'6-OctaCB-(205)	µg/kg	EPA 1668B	--	--	--	0.001	0.003
22'33'44'55'6-NonaCB-(206)	µg/kg	EPA 1668B	--	--	--	0.0009	0.003
22'33'44'566'-NonaCB-(207)	µg/kg	EPA 1668B	--	--	--	0.0009	0.003
22'33'455'66'-NonaCB-(208)	µg/kg	EPA 1668B	--	--	--	0.0009	0.003
DecaCB-(209)	µg/kg	EPA 1668B	--	--	--	0.0003	0.003
Monochlorobiphenyls	µg/kg	EPA 1668B	--	--	--	0.0006	0.009
Dichlorobiphenyls	µg/kg	EPA 1668B	--	--	--	0.01	0.04
Trichlorobiphenyls	µg/kg	EPA 1668B	--	--	--	0.007	0.07
Tetrachlorobiphenyls	µg/kg	EPA 1668B	--	--	--	0.01	0.13
Pentachlorobiphenyls	µg/kg	EPA 1668B	--	--	--	0.02	0.14
Hexachlorobiphenyls	µg/kg	EPA 1668B	--	--	--	0.01	0.13
Heptachlorobiphenyls	µg/kg	EPA 1668B	--	--	--	0.008	0.07
Octachlorobiphenyls	µg/kg	EPA 1668B	--	--	--	0.003	0.04
Nonachlorobiphenyls	µg/kg	EPA 1668B	--	--	--	0.0009	0.009
Decachlorobiphenyl	µg/kg	EPA 1668B	--	--	--	0.0003	0.003
Total PCBs	µg/kg	EPA 1668B	9	75	34	0.08	0.60

Notes:

[a] Units are provided on a dry-weight basis.

[b] Screening levels from EPA (2017) for the PHSS and DEQ (2001) for ecological SLVs.

[c] Detection and reporting limits based on clean sample. Elevated target and non-target compounds can lead to raised limits.

[d] The PHSS CUL of 12 µg/kg is modified to reflect the most recent EPA Integrated Risk Information System (IRIS) toxicity information resulting in a screening level of 85 µg/kg for protection of human health.

Acronyms:

ASTM = American Society for Testing and Materials
BaP Eq = Benzo(a)pyrene equivalents
cPAHs = carcinogenic polycyclic aromatic hydrocarbons
CUL = Cleanup Level
DEQ = Oregon Department of Environmental Quality
EPA = U.S. Environmental Protection Agency
MDL = method detection limit
mg/kg = milligrams per kilogram
µg/kg = micrograms per kilogram
NA = not applicable
NWTPH-Dx = Northwest Total Petroleum Hydrocarbons diesel-range
PAH = polycyclic aromatic hydrocarbon
PCB = Polychlorinated biphenyl
PDBE = Polybrominated diphenyl ether
PHSS = Portland Harbor Superfund Site
PSEP = Puget Sound Estuary Protocols
RAL = Remedial Action Level
SLV = Screening Level Value
SQL = sample quantitation limit
TEQ = Toxic Equivalency Quotient
-- = not available

Table 2 - Sample Containers, Preservation, Holding Times, and Sample Volume
Upriver Reach, Lower Willamette River
Portland, Oregon

Analysis	Method	Container Type[a]	Preservation	Holding Time[b,c]	Lab Sample Size[d]
Sediment Samples					
Total Organic Carbon	PSEP	WMG	4ºC	28 days	2 g
Total Solids	PSEP	WMG	4ºC	6 months	20 g
Grain Size Distribution	ASTM D422	WMG	4ºC[e]	6 months	1,000 g
Metals	EPA 6020B	WMG	4ºC	6 months	20 g
Mercury	EPA 7471B	WMG	4ºC	28 days	10 g
Diesel Range Hydrocarbons (with Silica gel clean-up)	NWTPH-Dx	WMG	4ºC	14 days	30 g
Dioxins/Furans	EPA 1613B	WMG	≤ -10ºC	1 year	30 g
Organochlorine Pesticides	EPA 1699M	WMG	4ºC	14 days	30 g
PAHs, SVOCs, Phenols, and Phthalates	EPA 8270D/SIM	WMG	4ºC	14 days	30 g
PBDEs	EPA 8270D or 1614	WMG	4ºC	14 days	30 g
PCB Congeners	EPA 1668B	WMG	≤ -10ºC	1 year	30 g
Archival	Frozen	WMG	≤ -10ºC	1 year	TBD
Equipment Rinsate Blank					
Total Organic Carbon	PSEP	PC	Sulfuric acid to pH <2; 4ºC	28 days	250 ml
Metals	EPA 6020B	HDPE	HNO_3 to pH<2; 4ºC	6 months	100 ml
Mercury	EPA 7470B	HDPE	HNO_3 to pH<2; 4ºC	28 days	100 ml
Diesel Range Hydrocarbons (with Silica gel clean-up)	NWTPH-Dx	AG	HCl to pH 2; 4ºC	14 days	500 ml
Dioxins/Furans	EPA 1613B	AG	Dark; 4ºC	1 year	1 L
PAHs, SVOCs, Phenols, and Phthalates	EPA 8270D/SIM	AG	Dark; 4ºC	7 days/40 days[f]	1 L
Organochlorine Pesticides	EPA 1699M	AG	Dark; 4ºC	7 days/40 days[f]	1 L
PBDEs	EPA 8270D or 1614	AG	Dark; 4ºC	7 days/40 days[f]	1 L
PCB congeners	EPA 1668B	AG	Sulfuric acid to pH 2-3; 4ºC	1 year	1 L

Notes:

[a] Size and number of bottles may be modified by lab.

[b] Holding time until extraction or frozen archival.

[c] Holding times for frozen sediment samples (stored at ≤ -10°C) is 1 year for all analyses except metals, which have a 2 year frozen holding time.

[d] Collection of approximately 3x normal sample size listed will be necessary for laboratory QC analyses.

[e] Samples must not be frozen or dried prior to analysis, as either process may change the particle size distribution.

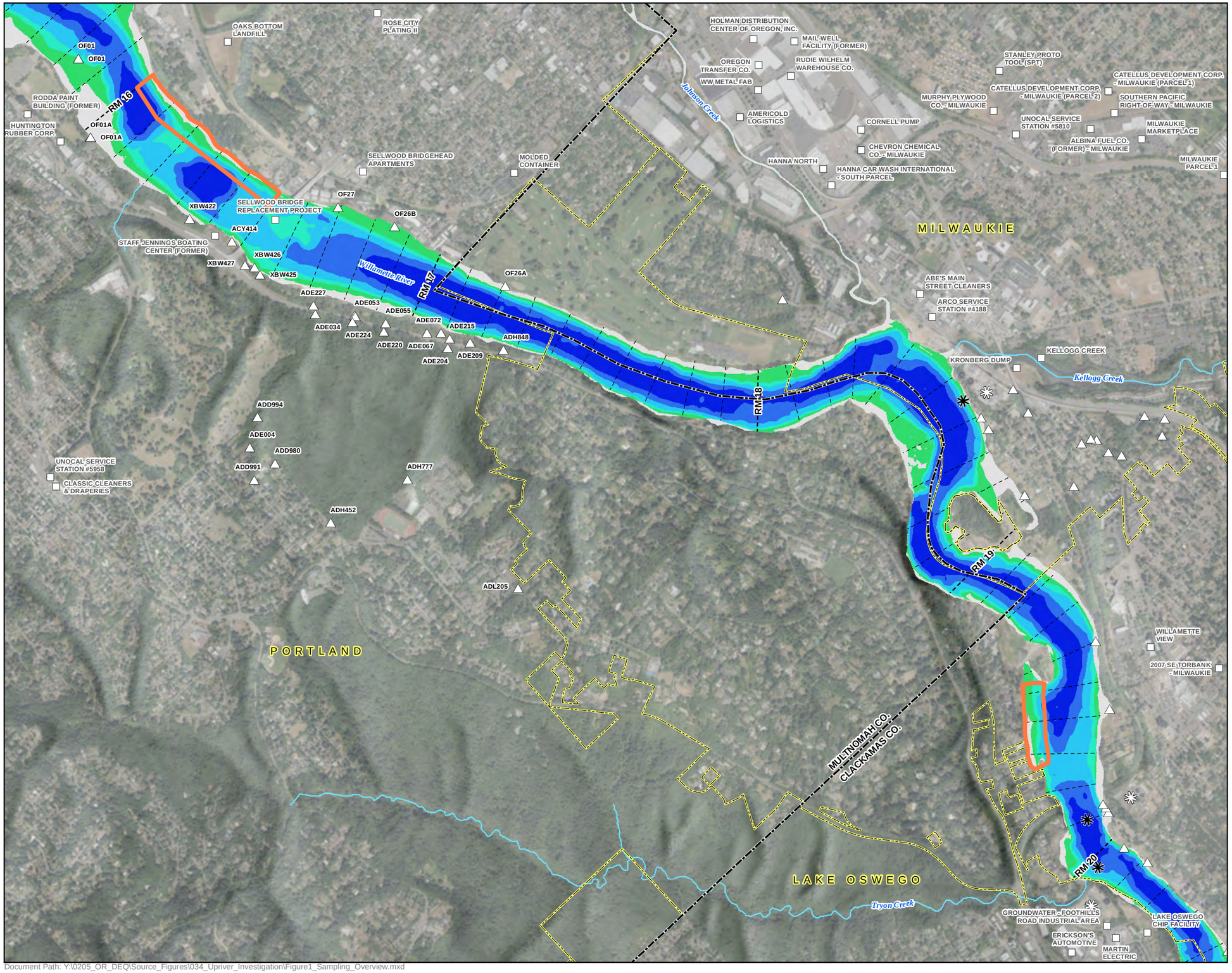
[f] Holding time is 7 days to extraction and extracts must be analyzed within 40 days from extraction.

Acronyms:

AG = amber glass
ASTM = American Society for Testing and Materials
EPA = U.S. Environmental Protection Agency
g = gram
HCl = Hydrochloric acid
HDPE = high-density polyethylene
HNO_3 = Nitric acid
L = Liter
ml = Milliliter
NWTPH-Dx = Northwest Total Petroleum Hydrocarbons diesel-range
PAHs = Polycyclic aromatic hydrocarbons
PC = polycarbonate
PCB = Polychlorinated biphenyl
PBDEs = Polybrominated diphenyl ethers
PSEP = Puget Sound Estuary Protocol
SVOCs = Semivolatile organic compounds
TBD = To be determined
WMG = wide-mouth glass

FIGURES

FIGURE 1
Upriver Reach
Proposed Sampling Overview
Sampling Analysis Plan



LEGEND

- Proposed Sampling Area

Bathymetric Surface[1]

- -10 to 0
- -20 to -10
- -40 to -20
- -60 to -40
- < -60

All Other Features

- River Mile (RM)
- DEQ ECSI Site
- Outfall
- Wastewater Treatment Plant
- Wastewater Treatment Plant Discharge Point (approximate)
- City Limit
- County Line
- Watercourse
- Waterbody

NOTES:

1. Elevations in feet are relative to Columbia River Datum (CRD), U. S. Army Corps of Engineers, Hydrographic Surveys, 1999

N

0 700 1,400 2,100
Feet

Date: October 14, 2019
Data Sources: BES, METRO, COP

GSI Water Solutions, Inc.

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FIGURE 2

Upriver Reach
Proposed Sampling Locations: River Mile 16.0 - 16.5 East

Sampling Analysis Plan

LEGEND

- Proposed Sampling Area

Proposed Sample Location

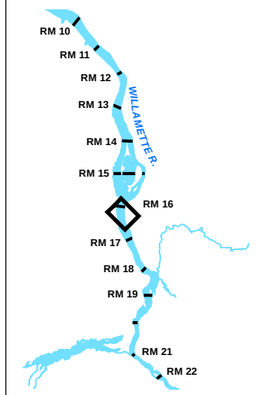
- Shoreline Sediment Sample
- Sediment Sample

Sample Locations

- Pre-RD Surface Sediment
- Surface Sediment
- Subsurface Sediment

All Other Features

- River Mile (RM)
- DEQ ECSI Site
- Outfall/Drainage Ditch



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Feet

Date: October 17, 2019
Data Sources: BES, METRO, COP

GSI Water Solutions, Inc.

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FIGURE 3

Upriver Reach
Proposed Sampling Locations: River Mile 19.4 to 19.7 West

Sampling Analysis Plan

RM 19.4

RM 19.4

RM19.4W-SED6

RM 19.5

SG-B471

RM19.5W-SED7

RM 19.6

RM19.6W-SED8

RM 19.7

LAKE OSWEGO

RM 19.8

LEGEND

Proposed Sampling Area

Proposed Sample Location

Sediment Sample

Sample Locations

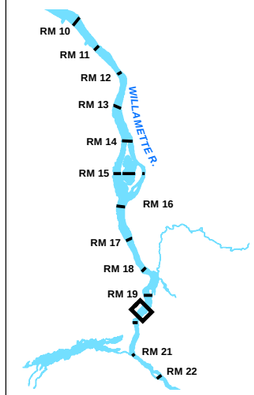
Pre-RD Surface Sediment

All Other Features

River Mile (RM)

Outfall/Drainage Ditch

City Limit



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Feet

Date: October 17, 2019
Data Sources: BES, METRO, COP

GSI Water Solutions, Inc.

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