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# Work Plan

## *Upriver Reach Sediment Characterization*

Lower Willamette River  
Portland, Oregon

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Prepared for

**U.S. Environmental Protection Agency**

Prepared by



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**Abbreviations and Acronyms**

µg/kg	microgram/kilogram
ASTM	American Standard Test Method
bml	below mudline
cm	centimeter
COC	contaminant of concern
cPAH	carcinogenic PAH
DDx	dichlorodiphenyltrichloroethane and breakdown compounds
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DEQ	Oregon Department of Environmental Quality
DM	Data Manager
ECSI	DEQ Environmental Cleanup Site Information
EPA	U.S. Environmental Protection Agency
FM	Field Manager
FS	feasibility study
GSI	GSI Water Solutions, Inc.
GPS	global positioning system
HDPE	high-density polyethylene
HPAH	high molecular weight PAH
HSP	health and safety plan
ISM	incremental sampling methodology
LCS	laboratory control sample
LPAH	low molecular weight PAH
MDL	method detection limit
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
NAD83	North American Datum of 1983
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEF	potency equivalent factor
PH	Portland Harbor Superfund Site
PO	Project Officer
QA	quality assurance
QAM	Quality Assurance Manual
QC	quality control
RI	remedial investigation
RM	river mile
ROD	Record of Decision
SAP	sampling and analysis plan
SMB	smallmouth bass
SVOC	semivolatile organic compound
TEF	toxic equivalency factor
TEQ	toxicity equivalency quotient
TOC	total organic carbon

URSC	Upriver Reach Sediment Characterization
USGS	U.S. Geological Survey
VOC	volatile organic compound
WP	work plan
WWTP	wastewater treatment plant

# 1 Introduction

This Upriver Reach Sediment Characterization (URSC) Work Plan (WP) presents the objectives, rationale, and approach for targeted discovery work to uncover any previously unidentified potential source areas in the Lower Willamette Watershed (see Figure 1). This WP also includes sampling and analytical methods and quality assurance (QA) and quality control (QC) protocols. The WP was developed by the Oregon Department of Environmental Quality (DEQ) with assistance from Hart Crowser and GSI Water Solutions, Inc. (GSI).

## 1.1 Background

On January 3, 2017, the U.S. Environmental Protection Agency (EPA) issued a Record of Decision (ROD) presenting the Selected Remedy for the Portland Harbor Superfund Site (PH) in the Willamette River. The PH extends from river mile (RM) 1.9 to 11.8 (see Figure 1). As indicated in the ROD, the PH cleanup addresses the lower portion of the Willamette River, which drains about 408 square miles of land in Portland, Oregon. This is a small part of the 187-mile-long river, which in its entirety drains 11,460 square miles or 12 percent of the State of Oregon. Although sediment cleanup and related source control efforts will greatly improve water quality in the PH and downstream areas, other efforts in addition to, or coordinated with, Superfund authorities can improve the overall environment of the Lower Willamette watershed. The URSC described in this WP is one such effort, conducted by the DEQ and funded by a \$100,000 EPA Cooperative Agreement (Agreement number -96089704-3).

The objective of the Cooperative Agreement funding the URSC is to “research and investigate possible sources of contamination in the lower Willamette River, i.e., downstream of Willamette Falls in Oregon City/West Linn, and relevant tributaries.” The Willamette River reaches most proximal to the Portland Harbor are the Downtown Reach (RM 11.8 to RM 16.6) and the Upriver Reach (RM 16.6 to Willamette Falls, approximately RM 26) (see Figure 1). DEQ has conducted and overseen multiple investigations in the Downtown Reach and identified several sources for further evaluation and cleanup. This work is ongoing and is implemented through DEQ’s Cleanup and Orphan programs.

Investigations in the Upriver Reach have been more limited than in the Downtown Reach, and sample data are sparse in this almost 10-mile reach of the Willamette River. Therefore, DEQ is focusing its effort to uncover any previously unidentified potential sources in the Upriver Reach that could negatively impact the success of the EPA’s Portland Harbor cleanup or the overall health of the Lower Willamette Watershed.

The URSC described in this WP is just one effort of several involving multiple agencies and stakeholders to better understand occurrence and sources of toxics in the Lower Willamette Watershed. A broader DEQ and EPA effort, called the Willamette Watershed Toxics Reduction Partnership, is underway to work collaboratively with stakeholders and interested parties to build on the current and planned efforts throughout the Willamette and Columbia River watersheds and identify new strategies to reduce contaminant loading in the watershed. An initial community meeting was held on May 24, 2017, a steering committee was formed, and progress is being made toward achieving these broader environmental improvements. Parties interested in becoming engaged in the Willamette Watershed Toxics Reduction Partnership are encouraged to visit the website: <https://www.epa.gov/columbiariver/willamette-watershed-toxics-reduction-partnership>

and attend upcoming meetings.

## **1.2 Purpose and Objectives**

This URSC is intended to reveal whether areas of potentially significant sediment impacts exist within the scarcely investigated 10-mile reach of the Willamette River upstream of downtown Portland. Areas identified for characterization are selected on the basis of review of available historical data, and proximity to potential sources. Examples of potential sources and transport pathways to the river include outfalls; past or present riverfront industries; land use that has the potential to impact the river, such as application of pesticides; and confluences of tributaries that have upstream sources of contamination.

Note that the investigation is not intended to be a comprehensive study of all potential contaminant sources, and it does not address all potential sources and transport pathways such as current and historical outfalls and industrial properties. The investigation is constrained by budget; potential source areas and data gaps are identified, and initial areas of interest are selected and prioritized on the basis of potential magnitude of impacts.

## **1.3 Document Organization**

This WP is organized into the following sections:

- Section 1 – Provides an introduction to the project and objectives.
- Section 2 – Describes the environmental and jurisdictional setting of the Upriver Reach of the Lower Willamette Watershed.
- Section 3 – Summarizes existing data, potential source areas, and potential data gaps.
- Section 4 – Summarizes the sampling and analytical approach for the URSC.
- Section 5 – Identifies key project team members and responsibilities.
- Section 6 – Describes station positioning, sample collection, and sample handling and custody procedures.
- Section 7 – Describes the laboratory analytical program, laboratory QA/QC requirements, and data validation procedures.
- Section 8 – Provides an overview of field and electronic data management procedures.
- Section 9 – Summarizes the project schedule and reporting requirements.
- Section 10 – References cited.

Supporting information is provided in Appendix A -Data Sources.

## **2 Upper Reach Setting**

The Upriver Reach is the most upstream portion of the Lower Willamette River, starting near the Sellwood Bridge at RM 16.6 and extending to Willamette Falls at approximately RM 26. While the Lower Willamette River is generally a wide, slow-moving segment that is tidally influenced, the Upriver Reach is narrower and faster moving than the downstream reaches. Land use and physical characteristics in the Upriver Reach are described below.



## 2.1 Land Use

The Upriver Reach portion of the river flows through multiple municipalities and two counties (see Figure 1). Land use is largely residential and mixed use residential, with some parks and open spaces (see Figure 2). Current industrial use in the Upriver Reach is limited to the Lake Oswego industrial area on the west shore between RMs 20 and 20.5, and near Willamette Falls at approximately RM 26, where papermaking facilities historically have been located.

DEQ identified twenty Environmental Cleanup Site Information (ECSI) sites near the river that were further evaluated as potential ongoing sources (see Section 3 Figures). Through this effort, upland sites were identified for additional assessment work. DEQ has initiated this work such that investigations can be conducted in parallel with, and inform the results of, this URSC effort.

## 2.2 River Bottom Substrate

River bottom substrate in the Lower Willamette River was evaluated in 2001 as part of the PH remedial investigation (RI) and provided in the *Willamette River Sediment Trend Analysis Report* (GeoSea, 2001). Sediment types vary widely in the Upriver Reach. However, there is a general trend from upstream to downstream with more, 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.

# 3 Available Data, Potential Sources, and Data Gaps

DEQ reviewed readily available historical data collected in the Upriver Reach in sediment, surface water, and aquatic organisms to identify areas of elevated chemical impacts. Because the data were generated by multiple entities to meet a variety of objectives, the available data are not easily assembled into consistent and compatible formats. However, the data are informative for identifying areas of elevated contaminant concentrations that may warrant additional investigation. Data evaluated include the following:

- Sediment data assembled and collected by the Lower Willamette Group for the Portland Harbor remedial investigation.
- Water and tissue DEQ toxics monitoring program data.
- Dredge material and leave surface characterization reports submitted to the US Army Corps of Engineers between 2009 and 2015.
- US Geological Survey (USGS) sediment data reported in the Journal of the American Watershed Resources Association in 2014.

Data are provided in Appendix A.

Identification of potential sources and transport pathways<sup>1</sup>, assessment of available historical data, and evaluation of river bottom substrate are described below by river mile and provide the basis for selecting areas for further characterization. A summary of locations selected for characterization, and the basis for selection, are provided in Table 1. Sampling areas are shown in Figures 3a (overview) to 3b through f (by approximately 2-mile segments), relative to historical sample locations and potential sources.

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<sup>1</sup> Note that location information for outfalls was not available for some municipalities; therefore, outfalls are depicted only for cities of Milwaukie, Oregon City, and Portland.

Sampling areas are approximate and may be adjusted based on field conditions. If insufficient fines are available for sampling, the sample location will be moved to an area with a more fines, provided the adjusted sample location meets the data quality objective identified for the area (e.g., the sample is anticipated to be representative of the potential source/transport pathway). If no such location is identified, river bottom substrate will be documented and the “optional” characterization area will be sampled (see below, Table 1, and Figures for optional location).

Because the Lower Willamette River is affected by semidiurnal tides and there may be occasional flow reversals in the Upriver Reach when river discharge is low, the shores are consistently described as west, for west/northwest shores, and east, for east/southeast shores.

### **3.1 RMs 16.6 to 17**

Existing data show an elevated concentration of PCBs (262 µg/kg) in one sediment sample (sample S-13-10 collected to inform the Sellwood Bridge construction permit in-water application) near the east shore. In addition, historical smallmouth bass (SMB) samples collected between RMs 16 and 17 were elevated at 158 micrograms per kilogram (µg/kg), 281 µg/kg, and 428 µg/kg (LW4-SB-16W-03, LW4-SB-16W-04, LW4-SB-16W-01) with the highest SMB tissue concentration of 634 µg/kg (LW4-SB-16W-02) collected near RM 16.5, near the west side of the bridge.

Potential sources and transport pathways in this area include outfalls, the former Staff Jennings Boating Center (ECSI 6056), and fill historically placed in the uplands. A characterization of sediment in support of a maintenance dredge application permit at the Waverly Marina did not show significant impacts in sediment in this area.

The City of Portland collected samples offshore of outfalls in August 2017 to evaluate the outfalls as a source of polychlorinated biphenyls (PCBs). In addition, DEQ is planning to conduct a sediment investigation in the fall of 2017 at RM 16.5 to further evaluate the PCB concentration near the east end of Sellwood Bridge and adjacent to the former Staff Jennings Boating Center.

The planned City of Portland and DEQ sampling will provide a good understanding of potential contamination and sources in this area; therefore, no additional sampling is planned as part of this URSC.

### **3.2 RMs 17 to 18**

Historical samples, LW3-UG03B and LW3-UG03C at approximately RM 17.1 mid-channel, and RM 17.9 on the east shore, respectively, exhibited slightly elevated concentrations of bis-2-ethylhexylphthalate (200 µg/kg and 180 µg/kg, respectively) and LW3-UG03C also had slightly elevated concentrations of total PCBs (40 µg/kg) and total chlordane (0.56 µg/kg). In addition, as indicated above, a SMB sample collected at RM 16.5 had a significantly elevated tissue concentration of 634 µg/kg, indicating a likely source of PCBs within approximately 1 mile downstream of the collection point.

The Waverly Golf Course encompasses the east shore between RMs 17 and 18. An active City of Portland outfall, OF26A, at RM 17.2, discharges on the east shore of the river and serves a 50-acre residential area. The river bottom substrate offshore of OF26A is sand and muddy sand.

The west shore from RM 17 to approximately RM 17.3 is heavily vegetated open space. South of RM 17.3 to RM 18 is almost entirely single family housing. The river bottom substrate is generally sand and muddy sand.

While there is some evidence of sediment impacts in the vicinity and elevated fish tissue concentrations downstream, no significant sources of contamination are readily apparent. Therefore, this area is not prioritized for characterization.

### **3.3 RMs 18 to 19**

A carp sample collected by DEQ in 1994 at approximately RM 18 and analyzed as a fillet (Sample TMP102) had elevated concentrations of PCBs (360 µg/kg) as well as dichlorodiphenyltrichloroethane and breakdown compounds (DDx) (55 µg/kg).

#### ***East Shore***

The east shore of this stretch of river is a mix of single family housing, mixed-use residential, and parks and open spaces. Two DEQ cleanup sites, Arco Service Station (ECSI 4188) and Kronberg Dump (ECSI 5843), are located on the east shore, but not immediately adjacent to the river. Both Johnson Creek and Kellogg Creek discharge on the east shore between RMs 18.3 and 18.5. One water sample was collected by DEQ in 2007 near the confluence of Johnson Creek; however, the sample was only analyzed for conventional parameters and limited metals. No concentrations exceeded water quality criteria. Both creeks have potential sources of or pathways for contamination, such as outfalls and DEQ cleanup sites, upstream of their confluence with the Willamette River. Surface sediment samples collected from Kellogg Lake in 2012 contained PCBs at 45 µg/kg to 58 µg/kg. Finally, the Kellogg Creek Waste Water Treatment Plant (WWTP) discharge is located at approximately RM 18.5. River bottom substrate varies in this area; however, there appears to be some accumulation of sand and fines close to shore.

There was an elevated DDx concentration (77.1 µg/kg) in a lamprey sample (LW3-LTA-Comp5) collected near Elk Rock Island at RM 18.7; however, DDx concentrations in nearby sediment were low.

Given the multiple potential sources on the east shore, and the elevated concentrations of contaminants in the historical carp sample, two areas are selected for characterization:

- Confluence of Johnson Creek (RM 18.35E)
- Confluence of Kellogg Creek and Kellogg Creek WWTP discharge location (RM 18.45E to 18.5E)

#### ***West Shore***

Historical sample LW3-UG04B collected at RM 18.4 on the western shore had polycyclic aromatic hydrocarbon (PAH) concentrations of 464.5 µg/kg in an area that appears to have significant accumulation of fine sediment. Samples collected directly upstream and downstream of the sample at approximately RMs 18.3 and 18.5 were lower in concentration. Further, dredge permit NWP-2013-227 issued in 2013 for dock maintenance dredging at RM 18.5 on the west shore indicated no significant contamination was present. The land use on the west shore is entirely single family residential with multiple private docking structures. Because samples upstream and downstream of the PAHs were low, and there are no obvious sources nearby, this area is not prioritized for additional characterization as part of the URSC effort.

### 3.4 RMs 19 to 20

One ECSI site, Willamette View (ECSI 2613), a retirement home, is located on the east shore at approximately RM 19.5; however, a No Further Action determination was issued and, given the distance from the river and other factors, a complete pathway to the river is not suspected. The remaining land use in the area on the east shore is single family housing with some private docks, and a small park (Riverville Park) along the river at RM 20.

The west shore land use is entirely single family housing, with multiple private dock structures along the river. The river bottom substrate on the east shore is largely hard ground with some sand close to shore.

No obvious significant sources are apparent in this stretch of the river; therefore, no further characterization is prioritized between RMs 19 and 20. Note that potential sources are identified below, near RM 20 on the west shore, and that sediment will be characterized in this area as described in the following section.

### 3.5 RMs 20 to 21

No historical data were identified between RMs 20 and 21; however, note that a SMB sample was collected just upstream, at approximately RM 21.2. As described in the section below, PCBs and DDx were detected in the sample.

On the east shore, a small park (Riverville Park) and the Oak Lodge Water Reclamation Facility discharge location are located at and just upstream of RM 20. The remaining land use on the east shore is single family housing with multiple dock structures. A small creek, Forest Creek, discharges at approximately RM 20.5. The discharge location for the reclamation facility and Forest Creek are selected for characterization.

On the west shore, Tryon Creek discharges at approximately RM 20. Sampling conducted by the USGS shows that a sample collected in the Willamette River downstream of Tryon Creek (not depicted on Figure, information obtained from Nilsen et. Al, 2014), had more detections of pharmaceutical compounds than most other sites on the Willamette River. Just upstream, the Tryon Creek WWTP discharges at approximately RM 20.04. Most Portland Harbor COCs were not analyzed in the USGS sample; therefore, the area is selected for characterization.

Between approximately RMs 20.1 and 20.3, multiple ECSI sites are located in a Lake Oswego industrial area. The river substrate at RM 20.1 is sand and muddy sand, indicating some potential for accumulation of fines and associated contaminants. Given that no sediment data are available in this area, the elevated concentration of PCBs in a SMB sample collected upstream, the proximity of potential sources, and the river substrate that lends itself to accumulation of contaminants, the area between RM 20.1W and 20.3W is selected for characterization and is referred to as sample composite area "RM 20.1W." Further, note that as a result of the URSC effort, DEQ initiated a separate, complementary effort to conduct a new assessment of Martin Electric (ECSI 71), where a historical release resulted in significant PCB contamination in soil. (Both DEQ and EPA had evaluated this site between 1989 and 1993).

Upstream of RMs 20.3 to 21 on the west shore is a combination of parks and open spaces, mixed use residential, and single family housing. Lake Oswego discharges at approximately RM 21. The river bottom substrate appears to consist largely of sand. RMs 20.9 to 21 (RM 20.9W) are selected for characterization because a significant water body discharges to this location, there is a lack of

sediment data in the vicinity, elevated concentrations of PCBs and DDX were detected in a SMB sample collected upstream, and some fines appear to accumulate nearby.

### **3.6 RMs 21 to 22**

One tissue and two sediment samples were collected historically between RMs 21 and 22. The tissue sample was from a SMB collected at approximately RM 21.2 in 2002 (sample ID LWG0120R001SB10). Concentrations of PCBs and DDX were detected at 120 µg/kg at 56.9 µg/kg, respectively. Sediment samples collected upstream at approximately RM 21.5 on the east shore in 1999 and the west shore in 2007 did not exhibit elevated PCB or DDX concentrations.

Land use on the east shore is entirely single family residential. On the west shore, land use is approximately half single family and mixed use residential and half public facilities, namely Marylhurst University. Multiple creeks discharge to the river from the west shore. The river bottom appears to consist largely of hard ground with some sand in areas close to shore.

Given a lack of likely significant sources, and historical sediment data showing no significant contamination, no sample collection is planned in this area. Note that sediment characterization is planned just downstream of where the PCB and DDX impacted SMB was collected, and may inform the source of the tissue contamination (see the previous section).

### **3.7 RMs 22 to 23**

Multiple sediment samples were collected upstream of RM 22.6 and three biological samples were collected on the east shore. Sediment samples collected on the east shore at approximately RM 22.7 had detected concentrations of PAHs (sample WLCMBJ99D09942 at 406 µg/kg) and Bis(2-ethylhexyl) phthalate (BEHP) (sample LW3-UG11C at 240 µg/k). The samples were collected in an apparent area of sand near the discharge location of a creek and multiple private dock structures. Tissue samples were generally low in contaminant concentration.

Land use on both shores is entirely single family residential with multiple dock structures. The river bottom is largely composed of hard ground with pockets of sand, gravelly sand, and muddy sand closer to shore.

Given the generally low levels of contamination in tissue and sediment, and the lack of significant apparent sources of contamination, no areas between RMs 22 and 23 are prioritized for further characterization.

### **3.8 RMs 23 to 24**

Historical sediment and biological samples were collected near and in the Cedar Island lagoon. A few chemicals, including PAHs (up to 286 µg/kg), DDX (up to 6.69 µg/kg), and chlordane (up to 1.18 µg/kg), were detected in sediment samples collected in the lagoon. PCB concentrations in tissue ranged from 5.6 to 24.8 µg/kg.

Cedar Island is a horseshoe-shaped island at approximately RMs 23 to 23.3 and is a municipal park in the City of West Linn. Historically, the island was dredged to mine gravel, creating a lagoon in the center of the island. The lagoon substrate is characterized as muddy sand. No point source of contamination is apparent at or near the island.

On the east shore, at approximately RMs 23.8 to 23.9, two sediment samples were collected close to and within Meldrum Bar Park where Rinearson Creek discharges; chemical concentrations in these samples were not elevated.

A SMB sample (LWG0120R001TSSBWBC30) collected at RM 23.8 had elevated concentrations of PCBs at 317 µg/kg and DDX at 105 µg/kg.

The land use on both shores is largely single family residential with multiple dock structures. Mary S. Young State Recreation Area is on the west shore from approximately RMs 23.8 to 23.4. A few creeks on the west shore discharge to the river. The river bottom on the east shore is largely hard ground while the west shore river bottom is generally composed of sand and sandy mud.

Concentrations in this reach are generally low level (except for the SMB sample at RM 23.8) with limited apparent nearby sources. Characterization is not planned in this area; however, sample areas are identified upstream (see next section) to evaluate, in part, the source of elevated SMB concentrations.

### **3.9 RMs 24 to 25**

#### *West Shore*

An elevated concentration of PCBs was identified at approximately RM 24.4 on the west shore of the river, in the channel west of Goat Island (sample WLFLH07WR04SD at 24.85 µg/kg); dioxin concentrations were also slightly elevated relative to other upriver reach concentrations at close to 4 ng/kg toxicity equivalent quotient. The river is bifurcated between RMs 24.4 and 24.9 by Goat Island.

Land use on the west shore is entirely single family residential. The river bottom substrate appears to be sand with some muddy sand in the channel between Goat Island and the west shore.

This area has the potential to accumulate contamination, and has some historical indication of elevated concentrations, although no nearby sources are apparent. This area is selected for “optional” characterization, and will be sampled if sufficient funding is available.

#### *East Shore*

A good portion of the land on the east shore is Meldrum Bar Park, a natural area with some sports fields. There are also multifamily residential areas on the east shore. The Clackamas River discharges at approximately RM 24.7. In the Willamette River, the river bottom is characterized as hard ground; however, it appears some sand accumulates just at the mouth of the Clackamas River.

Because a significant tributary with potential upstream sources of contamination discharges at this location, sediment characterization in the area has not been conducted, contaminants detected in fish tissue downstream, and there appears to be some accumulation of fines, this area is selected as a location for characterization.

### **3.10 RMs 25 to 26**

Multiple outfalls, a WWTP, Abernathy Creek discharge between RMs 25 and 26, and DEQ cleanup sites are located on both shores and upriver. The river bottom substrate on the east shore has been described as almost entirely hard ground, limiting the fines that could accumulate contamination and that would be available for sampling. One small area of sediment was sampled near RM 25.5 on the west shore, and also at approximately RM 25.3 on the east shore, below the Highway 205 overpass. No significant contaminant impacts were identified in these samples.

Given the multiple potential sources of and transport for contamination in this area, further characterization is prioritized, despite the historical description of the river bottom as hard ground

in this area. The River bends and widens between approximately RM 25.2 and 25.45, with potential for deposition of finer substrate on the east shore. Therefore, this area is selected for characterization.

## 4 Sampling and Analytical Approach

This section describes the sediment sampling design that will support the objectives of the URSC. The design and rationale for the sediment sampling event were developed on the basis of the objectives previously described and in consideration of the general river dynamics and unique features of the Upriver Reach. Conditions encountered in the field may result in some modifications to the sampling design, and any deviations from the WP will be documented in the data report.

Sample locations were selected as described in the previous section. The anticipated sediment sample locations are shown in Figures 3a through 3f and Table 1 summarizes the basis for sample selection.

### 4.1 Surface Sediment Composites

Surface sediment composites will be collected to characterize potential source areas.

The composites will be collected and processed similar to the incremental sampling methodology (ISM) described in Interstate Technology and Regulatory Council (ITRC) guidance (ITRC, 2012). ISM has been shown to produce results more representative of site conditions, and also is less likely to miss areas of significantly elevated concentrations (i.e., “hot spots”), than collecting and analyzing multiple discrete samples (ITRC, 2012). However, given the funding limitations, and the desire to maximize the number of areas of interest (AOIs) characterized in this 10-mile Upriver Reach, the standard ISM approach of collecting a minimum of 30 increments per decision unit is not feasible. Five increments will be collected at each location offshore of AOIs associated with discrete sources or transport pathways, such as outfalls, or constrained confluences such as Kellogg, Forest, and Tryon Creek, while a target of 10 increments will be collected in all other areas of interest given the potential larger spatial extent of impact. Samples will generally be collected downstream to upstream at locations where upstream sample activities could impact downstream decision units.

Increments will be composited consistent with ISM procedures. The number and location of increments may be reduced or relocated where river bottom substrates, such as debris or cobbles, inhibit sample collection (see Section 6). Increments within each composite area will be composited consistent with ISM procedures. Increments will be provided to the laboratory in a clean laboratory-provided 16- or 32-ounce container (the larger container will be used in areas with an abundance of rocks and pebbles). For each composite area, the laboratory will separately process each increment by sieving out the  $\geq 2$  millimeter (mm) size fraction and homogenize the remaining sediment; an equal mass of sediment from each of the 5 or 10 increments will be obtained and then combined for processing, homogenizing, and subsampling for the composite sample in a manner consistent with ITRC ISM guidance and the laboratory standard operating procedure (see Appendix B). The laboratory should gather enough mass from each container to be able to run the full analytical suite and have material left over for archival and potential future analysis. An extra container of sediment will be provided from each sample station for immediate frozen archival (no ISM processing needed).

## 4.2 Analyses

Samples will be analyzed for the Portland Harbor focused contaminants of concern (COCs): PCBs, PAHs, polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans (PCDD/F), and DDx. In addition, Portland Harbor sediment COC metals, chlorinated pesticides, diesel-range petroleum hydrocarbons, pentachlorophenol, and bis(2-ethylhexyl)phthalate (see Section 7.2) will be analyzed. Polybrominated diphenyl ethers (PBDEs) will also be included in the analyte list. While tributyltin is a Portland Harbor sediment COC, this contaminant tends to be limited in occurrence to activities related to ship maintenance or ship breaking. No such historical activities have been identified in the Upriver Reach areas; therefore, tributyltin analysis is not planned.

Conventional analysis will include total solids, total organic carbon (TOC) and condensed grain size analysis.

All samples will be archived at the laboratory for a minimum of 6 months.

## 5 Project Organization

This section summarizes the organizational structure, responsibilities, and resources used to support the implementation of the WP.

### 5.1 Team Organization and Responsibilities

EPA is funding and reviewing the work. DEQ is leading implementation of the work with assistance from contractors, Hart Crowser and GSI. Roles and responsibilities on the project team are discussed in the following sections.

#### 5.1.1 EPA Cooperative Agreement Project Officer

Joanne Labaw is the EPA Cooperative Agreement Project Officer. In accordance with the Cooperative Agreement, DEQ provides work plans and contractor task orders to the EPA Cooperative Agreement Project Officer for review and approval before authorizing or implementing work.

#### 5.1.2 DEQ Cooperative Agreement Program Manager

Gil Wistar manages site assessment Cooperative Agreement work, including the work conducted under the task described in this WP.

#### 5.1.3 DEQ Project Officer

Madi Novak is the DEQ Project Officer (PO). In this role, she led development of this WP, and will lead and oversee implementation of the final, EPA-approved work plan, including reporting on the results of the investigation. She is in direct contact with the EPA and DEQ Cooperative Agreement Project Officers and Managers, and coordinates DEQ contractors, including the FM, to implement the work and ensure the project objectives are achieved.

#### 5.1.4 Field Manager

Erin Carroll Hughes (GSI) is the Field Manager (FM) and will be in direct contact with the DEQ PO. The FM or alternate staff in direct communication with the FM will be present on the boat and assist the field crew with the following responsibilities:



- Assist sampling efforts and coordinate daily field and laboratory activities.
- Track schedule and performance of the sampling and analysis activities according to this WP.
- Provide solutions to problems if they occur.
- Consult or inform the PO of any decisions that involve significant changes to the SAP.
- Function as the field safety officer.

She has extensive experience implementing sampling and analytical programs consistent with Portland Harbor protocols and will ensure that the field protocols and methods are followed.

### 5.1.5 Quality Assurance Managers

QA managers have been assigned for field sampling activities and laboratory services. All QA managers will report to the FM and any issues will be brought to the attention of the PO.

**Chemistry QA Manager.** Anne Conrad (Hart Crowser) is the Chemistry QA Manager. She will perform oversight of the contract laboratory and will conduct the third-party QA review of the analytical data. She will add qualifiers, as required during data review and validation, and prepare a data validation report, which will be appended to the URSC final data report.

### 5.1.6 Data Management

GSI will provide a Data Manager (DM) and will maintain the project database. The Chemistry QA Manager will provide validated laboratory results as electronic deliverables to the DM. The DM will coordinate with the FM to determine the appropriate database structure, verify the satisfactory electronic transfer of validated data, maintain the integrity of the database, and oversee all data queries and reporting.

### 5.1.7 Laboratory Services

Laboratory services are currently being procured. The selected laboratory will perform the chemical analyses of all sediment samples. The laboratory project manager will oversee the laboratory's performance in accordance with this WP.

## 5.2 Health and Safety

The primary hazards for the sampling event are physical hazards associated with the river environment and working on a vessel with moving (and heavy) equipment. The field crew will exercise sound field judgment and practices to maintain a safe working environment during sample collection and during all field activities described in this WP. The field crew and activities will comply with HAZWOPER regulation under 29 CFR 1910.120. DEQ and contractors will prepare their own Health and Safety Plan (HSP) and be responsible for their own health and safety. As noted above, the FM will function as the field safety officer during the field work and while on the vessel and will determine the limits of safe practice and operating conditions during field activities. The FM will provide a safety briefing at the beginning of the field work and periodically during the sampling event, as needed (e.g., when conducting new or different field activities). The FD also will provide a safety briefing to any new participant involved in the field activities.

## 6 Sample Collection Procedures

### 6.1 Sampling Vessel Requirements

A sampling vessel equipped with a power-grab sampler will be used to collect surface sediment samples from the upper 30 centimeters (cm) of the riverbed. The sampling vessel will be operating in shallow water areas nearshore and need to maneuver around in-water and overwater structures. Consequently, the sampling vessel should be sufficiently shallow draft (preferably less than or equal to 2.5 feet) and nimble enough to access the targeted sampling locations. The sampling vessel should be equipped with an A-frame and hoist that provides sufficient strength capacity to deploy and retrieve the weighted power-grab sampler vertically over the sampling location. The vessel operator (a.k.a captain) should be experienced in navigation and power-grab sample collection and be prepared to stabilize the boat during sample collection through the use of the boat motors instead of anchors.

### 6.2 Navigation and Station Locating

Station positioning will be accomplished using a high-resolution global positioning system (GPS) with pre-loaded target sample location coordinates. The standard projection method to be used during field activities is Horizontal Datum: North American Datum of 1983 (NAD83), State Plane Coordinate System, Oregon North Zone. While sub-foot accuracies will be sought by using a high-resolution GPS, such as the dual frequency Trimble GeoXH, position accuracies up to  $\pm 6$  feet may be accepted if more accurate positioning difficulties are encountered (e.g., insufficient satellite coverage). Station accuracy may be affected by satellite positioning and obstructions, such as the Sellwood Bridge, large vessels, docks, and heavy cloud cover. The coordinates for each individual grab sample location will be recorded by the Captain while the power-grab sampler is on the river bottom; the Captain will provide an electronic copy of those coordinates to the FM upon completion of the fieldwork. The FM, or other designated field staff on the vessel, will either record the sample coordinates in the field logbook and/or take a photo of the recorded coordinates on the GPS as a backup. Difficulties in achieving satellite coverage will be noted in the field logbook.

Station positioning using the sampling vessel for surface sediment power-grab sampling and by onshore personnel for riverbank sediment, are described below.

#### 6.2.1 Power-Grab Sampling from a Sampling Vessel

The Captain will operate the GPS and position the grab sampler as close as possible to the target sample location. After the sampling equipment has been deployed, the actual latitude and longitude coordinates will be obtained when the equipment is on the river bottom, using the on-board GPS system positioned on the A-frame directly above the power-grab sampler.

Vertical positioning is required to establish the elevation of the river bottom at the sampling locations. While the sampling device is in place at the sampling station, depth to the river bottom will be measured and recorded to the nearest 0.1 foot below the water surface using a lead line. Willamette River stage data are recorded on a 30-minute basis from U.S. Geological Survey (USGS) station number 14211720. This station is located on the upstream side of the Morrison Bridge (RM 12.8). River stage elevation data reported by USGS are relative to the Portland River Datum at this location. The depth to river bottom measurements will be combined with the corrected river stage data to estimate an elevation of the river bottom at each sample location.

## 6.2.2 Manual Sampling by Onshore Personnel

Field staff personnel will use either an iPad equipped with an EOS Arrow 100 sub-meter Bluetooth GNSS (GPS) receiver or a Trimble Global Positioning Unit, with pre-loaded sample coordinates and aerial imagery to locate the target discrete grab sample locations in the field. After locations are confirmed, sample coordinates and elevation near the mudline will be recorded. The presence (and depth if applicable) of surface water at the sampling location also will be recorded. Note that the vertical accuracy of the GPS elevations are approximate, as they are typically accurate to within 3 feet. If surface water is present, the depth also can be used in conjunction with the Morrison Bridge USGS data to estimate a mudline elevation.

During sediment sampling, the combination of river levels and subsurface obstructions may preclude collecting a sample at the target location. If this occurs, the collection location will be moved no more than 30 feet from the target location to an area that has comparable sediment characteristics to satisfy the rationale and objectives for the sample. If sample locations must be moved more than 30 feet from the initial target or abandoned completely, the proposed change will be verified with the PO.

## 6.3 Sample Collection Procedures

As described in Section 3 of this WP and shown on Figures 3a through 3f, 11 composite sampling areas have been identified for further characterization. In each composite area, either 5 and 10 individual grab samples will be collected and submitted to the laboratory for homogenization, analysis, and archival as described in Section 7. Surface sediment sampling will include the collection of two types of grab samples: power-grab and manual-grab.

### 6.3.1 Power-Grab Sampling from a Sampling Vessel

Before sampling, target station coordinates will be entered into the vessel navigation system as described in Section 6.2.1. The power-grab sampler will be attached to the hoist line, which will raise and lower the device through the water column at a rate slow enough to ensure that the sampler does not flip over on descent and will prevent disturbance of the sediment surface upon retrieval. After the sampler is brought on board the vessel, it will be placed on a stand or table to allow for visual characterization of the sediment surface to assess sample acceptability.

The target depth for sample collection is 30 cm bml. However, given the anticipated limited surface fines in the Upriver Reach, a minimum penetration of 15 cm will be acceptable. If a 15-cm penetration cannot be attained within three attempts conducted within 30 feet of the initial target, the sampling crew will go to the next discrete station. Following consultation with the PO, the target coordinates at the unsuccessfully sampled station may be adjusted, a lesser penetration depth may be accepted, or the discrete sample increment may be abandoned. Penetration depth within each decision unit should be approximately consistent.

If the FM deems the sample acceptable, the sample will be photographed before sample collection and characterization. If there is excess water present in the sampler, that water will be removed by siphoning. Because an undisturbed sediment surface is desired for chemical sampling, the physical characterization of the sediment in the grab sample will be delayed until after the chemical samples have been collected. Sediment for chemical analyses will be collected from the full depth of the sampler using hand tools as described below for soft sediment (fine-grained silts and sands) and rocky sediment, respectively:

- Where soft sediment is present, sediment samples will be collected by driving a 1.5- or 2-inch-diameter coring device (e.g., stainless steel, aluminum, or high-

density polyethylene [HDPE] tube) through the center of the grab-sampler and collecting material representative of the full depth of the sampler. The full sample volume then will be extruded from the sampling device and placed into a pre-cleaned 16-ounce glass sample container that is labeled for inclusion in the composite sample from that sample area. A second “plug” of sediment will be collected using the same technique from within the same power-grab bucket and placed in a second pre-cleaned 16-ounce glass sample container that is labeled for frozen archival.

- Where rocks or other obstructions are present, the archival and composite sample volumes will be collected manually using a stainless-steel spoon, scooping material from the full depth of the sampler. Sediment that is in contact with the sides of the sampler will be avoided. Large rocks, organisms, and pieces of debris will be removed and noted in the sample description form. Sediment from each station will be placed in a 16-ounce jar for archival and either a 16-ounce or 32-ounce jar marked for homogenization by the laboratory. Where pebbles and rocks are included in the sample, extra volume (i.e., the 32-ounce jar) will be provided for the composite sample to ensure the lab has enough material for processing and analysis.
- The laboratory will sieve and homogenize the individual increments separately, before collecting an equal mass aliquot from each discrete location and combining those aliquots using the ISM laboratory protocols. All remaining material from each aliquot will be archived frozen for potential future analysis.

The following physical characteristics of the grab samples will be described and recorded on a sample description form or in an iPad application: sediment texture; sediment color; presence, type, and strength of odors; grab penetration depth (nearest cm); degree of leakage or sediment surface disturbance; and any obvious features or characteristics, such as wood or shell fragments or large organisms. In addition, at least one photo of each successful grab sample will be taken.

### 6.3.2 Manual-Grab Sampling by Onshore Personnel

As described in Section 4 and Table 1, four areas are identified for collection of multi-point composite samples from 30-cm depth along the shoreline of the river. Each composite sample will be composed of discrete surface sediment grab samples obtained from 5 or 10 stations at approximately evenly spaced intervals across each composite area. Samples will be collected above the waterline at low river stage. The target depth for sample collection is 30 cm bml, with a minimum acceptable penetration of 10 cm. If a 15-cm penetration cannot be attained within three attempts conducted within 30 feet of the initial target, the sampling crew will go to the next discrete station. Following consultation with the PO, the target coordinates at the unsuccessfully sampled station may be adjusted, a lesser penetration depth may be accepted, or the discrete sample increment may be abandoned.

Shoreline sediment samples will be manually collected from shore using hand tools. Where soft sediment is present, grab samples will be collected from each station by driving a 1.5- or 2-inch-diameter coring device (e.g., stainless steel, aluminum, or HDPE tube) 30 cm into the sediment and collecting the full volume of the extracted material. After retrieval, each sediment cores will be measured for acceptable recovery, which is targeted to be a minimum of 15 cm. Separate “plugs” of sediment will be collected for the archival containers versus increments for the composite sample, but those will be collected within 2 feet of each other. Where rock or other obstructions are present, grab samples will be collected using a stainless-steel spade or shovel. At least three

attempts will be made to collect sediment subsamples within a 30-foot radius of the planned grab sample location before reducing the number of subsamples collected. An attempt will be made from the field to contact and notify the PO if it is determined that it is necessary to reduce the number of subsamples collected.

Acceptable samples will be characterized and sampled in a manner consistent with the power-grab samples described above.

#### 6.4 Field Quality Control Samples

Field QC samples are used to assess within-station variability (e.g., replicates), evaluate the effectiveness of sample homogenization and within-sample variability (e.g., splits), evaluate potential sources of sample cross-contamination (e.g., rinsate and trip blanks), or confirm proper shipping/storage conditions (e.g., temperature blanks). The types of QC samples that will be collected during the URSC sampling event include:

- **Rinsate Blanks.** The introduction of chemical contaminants during sampling and analytical activities will be assessed by the analysis of rinsate blanks. Rinsate blanks are generated by pouring purified water over decontaminated equipment and collecting the rinsate. They are used to assess potential contamination of samples resulting from improperly decontaminated sampling equipment.
- **Field Duplicates.** Field split samples, also called “field duplicate” samples, are multiple samples taken from a single sample composite after it is fully homogenized. Given that the contract laboratory is homogenizing the sediment using ISM protocols, a true field duplicate will not be collected. However, laboratory duplicates will be conducted as part of the laboratory QA/QC process (see Section 6.3). At the discretion of the PO, the laboratory may be asked to perform a laboratory split, collecting 30 separate increments from the archived ISM sample to reanalyze samples where elevated concentrations of one or more analytes are initially reported. If performed, the laboratory split will provide information on the variability associated with laboratory sample preparation/handling and analysis operations.
- **Field Replicates.** Field replicates sometimes are collected to assess natural variability associated with the environment and laboratory analyses, and to enable certain statistical analysis of the resulting data. Their origin is not revealed to the laboratory (also called a “blind” replicate). Field replicates involve collection of new sediment at the sampling location, not by subsampling from a composite sample. The assessment of sediment heterogeneity is not a primary objective of the URSC and, therefore, replicate samples will not be collected. One field replicate will be collected as part of the RM 16.5 sediment characterization and those results will be discussed in the URSC report.

In accordance with Table A7-1 of the DEQ QAPP, rinsate blanks will be collected at a rate of 1 per 20 samples in each medium (i.e., at least 5 percent). Given that there are 11 sample composite areas, one rinsate blank will be collected and analyzed for the full analytical suite as the parent sample, as listed in Table 2. In addition to this QC sample, a temperature blank will be included in each cooler to measure and ensure cooler temperature upon receipt of samples at the laboratory. Trip blanks are not required because volatile organic compounds (VOCs) are not a target analyte in this investigation.

## 6.5 Sample Handling, Transport, and Custody

Sample quality must be maintained throughout the collection, transport, storage, and analysis process. Sample handling, transport, and custody protocols will be consistent with those specified in Section B3 of DEQ's QAPP for EPA PA/SI Investigations (DEQ, 2012) and added specifications provided in this WP. Field activities will be fully documented (Section 8.1) and custody procedures followed to help ensure data integrity.

All analytes in sediment are compatible with collection and storage in wide-mouth glass jars and no field preservation is required (Table 3). Commercially available, pre-cleaned and certified jars will be provided by the laboratory. As described in Section 6.3, sample aliquots representative of the full sample depth will be provided to the laboratory for ISM homogenization and processing (see Section 7). Because environmental samples are not being collected for VOCs or for toxicity tests in which oxidation of sulfides may be of concern, compositing and homogenizing of the sediment is acceptable. Sample containers will be clearly labeled at the time of sampling. Labels will include the project name, sample location and number, analysis to be performed, date, and time. The nomenclature used for designating field samples is described in Section 7.1.4.

Sediment samples will be stored on ice before unloading onshore. At the end of each day, samples will be stored in coolers with ice or refrigerators at a pre-determined temporary storage location (e.g., GSI's downtown Portland office) before transfer to the contract laboratory via courier and/or shipping. Each cooler in which samples are packed will be sealed and accompanied by a copy of the chain-of-custody record that is sealed in a zip-lock bag and taped to the inside lid. At least one signed and dated custody seal will be present on each cooler before transfer to the laboratory. Whenever possible, samples will be directly transferred to the contract laboratory courier for transport to the laboratory. Transfer of samples will follow standard custody procedures and be noted on the chain-of-custody form.

## 6.6 Equipment Decontamination Procedures

Equipment and supplies will include sampling equipment, utensils, decontamination supplies, sample containers, coolers, logbooks and forms, personal protection equipment, and personal gear. Protective wear (e.g., hard hats, gloves), as required for the health and safety of field personnel, will be as specified in the HSP.

Given that the samples will be homogenized by the laboratory, equipment that comes in direct contact with the sediment samples can be minimized. That said, the stainless-steel or aluminum coring device used to collect the samples from either the power-grab sampler or the shoreline will need to be decontaminated between each individual sample location. That device and any other stainless-steel trays or spoons used to facilitate sample collection and/or observation will be decontaminated in the following manner before use at each station:

- Rinse with tap (or site) water, using a brush if needed to remove particulate matter and/or surface films.
- Wash with brush and Liquinox or other phosphate-free detergent.
- Double rinse with distilled water.
- Rinse with methanol or ethanol.

Given that most of the sampling equipment is stainless steel or aluminum, nitric acid will not be used in the decontamination procedures because of the risk of mobilizing metals from the stainless-steel sampling equipment.

Sample handling equipment that has been decontaminated but is not immediately needed, may be wrapped in aluminum foil and stored in a clean container for later use. To minimize sample contamination, gloves will be replaced or thoroughly washed using a phosphate-free detergent and rinsed with distilled water before and after handling each sample, as appropriate.

Between discrete samples and composite areas, the power-grab sampler will be washed using phosphate-free detergent and rinsed with site water. As noted in Section 6.3.1, sediment will be sampled from the middle of the sampler to avoid material in direct contact with the sides of the power-grab sampler.

## **6.7 Investigation-Derived Waste Management**

Any excess water or sediment remaining after processing will normally be returned to the river in the vicinity of the collection site. Similarly, any water or sediment spilled on the deck of the sampling vessel will be washed into the surface waters at the collection site before proceeding to the next station. Decontamination solutions containing methanol/ethanol will be held in sealed plastic buckets and disposed of at an onshore facility at the conclusion of the sampling event.

It is not anticipated that there will be contact with oily or other obviously contaminated sediment during this sampling event. However, if such material is encountered, it will be retained, to the extent practicable, and tested to inform proper disposal mechanisms.

All disposable materials used in sample collection and processing, such as paper towels and disposable gloves, will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies will be collected by sampling personnel and placed in a normal refuse container for disposal at a solid waste landfill.

## **7 Laboratory Analysis and Quality Assurance/Quality Control**

This section summarizes the analytical program that will be performed on samples collected during the URSC. Procedures for chemical analysis and laboratory QA and QC will be at least as stringent as those specified in DEQ's QAPP for EPA PA/SI Investigations (DEQ, 2012) and added specifications provided in this WP. The QAPP employs EPA, American Standard Test Method (ASTM), and other regulatory-accepted methods and protocols. Routine laboratory QA activities are further documented in the contract laboratory's Quality Assurance Manual (QAM), which adheres to consensus standards adopted by the National Environmental Laboratory Accreditation Program (NELAP). The selected laboratory will have a current Oregon Environmental Laboratory Accreditation Program (ORELAP) or The NELAC Institute (TNI) accreditation for the contracted analyses. These protocols will be followed to ensure that data quality and representation are in accordance with method requirements and that data usability is appropriately assessed for the project objectives.

### **7.1 Laboratory Homogenization**

As discussed in Section 5, sediment from 5 or 10 stations (the increments) in each composite area will be collected and provided to the laboratory. For each increment, the laboratory will sieve out material > 2mm and homogenize the remaining material. The laboratory will take an equal mass from each increment, combine them, and implement standard ISM processing and subsampling protocol described in Sections 11.7.1.7 and 11.7.1.8 of the Laboratory SOP (see Appendix B). Note

the material will not be dried during processing. This structured ISM protocol reduces data variability, increases sample representativeness, and reduces the chance of missing significant contamination in a volume of sediment targeted for sampling over standard field homogenization techniques. The selected contract laboratory should provide and follow their own ISM standard operating practices, after it is approved by the PO.

## 7.2 Physical and Chemical Analysis

All sediment samples will be analyzed for the same broad suite of parameters including: PCB; metals; PAHs; diesel-range hydrocarbons; organochlorine pesticides; PCDD/Fs; select phenols and phthalates; and polybrominated diphenyl ethers. Total solids and TOC also will be analyzed at each station. Laboratory methods and the associated method detection limits (MDLs) and method reporting limits (MRLs) for all target analytes are summarized in Table 2. MDLs and MRLs should be comparable to or better than those attained as part of the Portland Harbor RI and in all cases the MDLs should be lower than applicable cleanup levels specified in the ROD (see Table 2). The MDL will be adjusted by the laboratory, as necessary, to reflect sample dilution or matrix interference.

## 7.3 Laboratory QA/QC Procedures

Laboratory QA/QC will be maintained through the use of standard EPA methods and other accepted methods and standard analytical procedures for the target analytes. The method-specific and other analytical and laboratory QC procedures and protocols followed are detailed in the DEQ QAPP and the contract laboratories QAM. These procedures incorporated the collection and analysis of the following laboratory QA/QC components:

- Internal QC samples
- Method reporting limit checks
- Method blanks
- Matrix spike (MS) and matrix spike duplicate (MSD) samples
- Laboratory control samples (blank spikes)
- Surrogate spikes
- Calibration curves and calibration check samples
- Laboratory replicates

The frequency and QC criteria for the laboratory QC samples is provided in Table A7-1 of the DEQ QAPP.

## 7.4 Data Review, Verification, and Validation Procedures

Field and laboratory data for this project will undergo a formal Level II verification and validation process. Data verification and validation will be conducted in accordance with *Guidance on Environmental Data Verification and Data Validation* (EPA, 2002). Data verification and validation for organic compounds and metals will be completed according to methods described in the EPA guidance for data review (EPA, 2008, 2010, 2011). Performance-based control limits established by the laboratory and control limits provided in the method protocols will be used to evaluate data quality and determine the need for data qualification. Control limits and assessment criteria for field and laboratory QC samples are provided in Table A7-1 of the DEQ QAPP and the contract laboratory QAM and will be used for data validation.



Validation of the analytical data will be completed generally following EPA CLP National Functional Guidelines for Organic Data Review (EPA, 2008), Inorganic Data Review (EPA, 2010), EPA National Functional Guidelines for Chlorinated Dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs) Data Review (EPA, 2011), and EPA Region 10 standard operating practices for validation of PCB Congener data (EPA, 1995), but in the context of method-specific and laboratory-established QC requirements, and other EPA-approved or -accepted methods and protocols for analysis of URSC analytes, as applicable. No guidelines are available for validation of data for conventional analyses and physical testing, therefore, these data will be validated using procedures described in the functional guidelines for inorganic data review (EPA, 2010), but in the context of method-specific and laboratory-established QC requirements, as applicable. Analytical QC measurements will be performed on sample matrices from the URSC project alone; samples from other projects will not be mixed with the URSC sample analyses.

The FM will coordinate with the contract laboratory during sample analysis and delivery of analytical results. The Chemistry QA Manager will perform data validation of the reported results to document the performance of the laboratory analyses and to determine the usability of the data toward meeting project objectives. Data validation generally will address the following components:

- Case narratives discussing analytical problems (if any) and procedures.
- Chain-of-custody documentation to verify completeness of the data set.
- Sample preparation logs or laboratory summary result forms to verify analytical holding times were met.
- Results for applicable instrument tuning, initial calibrations, and continuing calibration verifications results to assess instrument performance (summary of results review only).
- Results for applicable instrument blanks (i.e., initial calibration blanks and continuing calibration blanks) and method blanks, to determine whether an analyte reported as detected in any sample was the result of possible contamination introduced at the laboratory.
- Results for applicable internal standards performance to ensure that instrument sensitivity and response were stable during the analysis of the samples.
- Results for applicable surrogate compound, laboratory control sample (LCS or blank spike), duplicate LCS, MS, and MSD recoveries to assess analytical accuracy.
- Results for applicable laboratory duplicate sample, duplicate LCS, and MSD analyses to assess analytical precision.
- Review of laboratory summaries of analytical results.
- Review of field/lab duplicate relative percent differences.
- Review of rinsate blank results relative to MDL and detected concentrations in project samples.

For consistency with the *Portland Harbor Remedial Investigation/Feasibility Study*, analytes detected at concentrations between the MRL and the MDL will be reported with a J qualifier to indicate that the value is an estimate (i.e., the analyte concentration is below the calibration range). Non-detects will be reported at the MDL with a “U” qualifier. The use of qualifiers applied during validation will

be consistent with those used in the PH RI and include only the following letters and combinations thereof (e.g., UJ):

Qualifier	Description
J	Estimate
N	Presumptive evidence of compound
R	Rejected
U	Not detected at value shown

Final, qualified (as necessary) laboratory results will be transmitted in electronic format to the Data Manager for data management, further evaluation, and reporting. The Data Manager will add a “T” qualifier to any calculated totals (see Section 8.2). The findings of the validated data will be presented in a data quality assessment report that will be appended to the final data report for the URSC sampling event (Section 9).

## 8 Data Management

### 8.1 Field Data Management

#### 8.1.1 Field Documentation

Field activities and observations will be documented in field logbooks during implementation of the sampling activities. Grab sample description forms will be completed for all samples. Chain-of-custody forms, which document sample possession and handling from the time of collection through relinquishment to the primary contract laboratory, will be maintained as part of the field records.

All field records will be copied, scanned, and/or entered into an electronic spreadsheet to create an electronic record for the project file. QA reviews by the FM will check for electronic/hard copy consistencies and identify anomalous values or erroneous entries.

#### 8.1.2 Sample Identification

All samples from the URSC will be assigned a unique identification number that will consist of two components, which will indicate the composite area, station number, sample type, and field QC sample type:

- The first component identifies the individual composite area by river mile (RM) and bank (E=East, W=West).
- The second component for the various discrete sediment grabs that go into each composite sample will begin with a “G,” representing a grab surface sediment sample type, and will be followed by the unique station identification number. The station number will begin at 001, with leading zeros will be used for stations with numbers below 100 for ease of data management and correct sorting.

- The second composite of the composited sample, will be “Comp,” indicating that it is a composite of all of the discrete sediment grab samples collected in each composite area.

Field QC samples will be identified by replacing the second component with a “D” for field duplicate or a “RB” for equipment rinsate blanks.

The following are examples of unique sample identifiers:

- RM17.5E-Comp: Composite sample from the composite area located on the east bank at RM 17.5 (RM 17.5E).
- RM17.5E-G001: Archive grab sample number 001 from composite area RM 17.5E.

A “RB” suffix will be added to identify the equipment rinsate blank and field/lab duplicate samples, respectively.

## 8.2 Electronic Data Management

Validated laboratory results will be provided as electronic deliverables to GSI by the Chemistry QA Manager. GSI will coordinate with the Chemistry QA Manager to determine the appropriate database structure, verify the satisfactory electronic transfer of validated data, maintain the integrity of the database, and oversee all data queries and reporting. QC measures will include checking for potential errors such as date and time formats, text field lengths, and that QA/QC data have matching parent samples. Original copies of electronic data that are uploaded successfully will be saved for purposes of documenting and tracking the data. Validated electronic data will be entered into the project database and spot-checked against the hard copy laboratory results for accuracy and completeness.

An Excel flat file containing all of the URSC results and calculated analyte group totals will be generated and included in the data report (Section 9). Electronic data management protocols generally will be consistent with those developed for the rest of Portland Harbor, but the data will be handled using MS Excel and MS Access rather than EQUIS® database (EarthSoft, Inc.).

### 8.2.1 Data Reduction and Handling

Data reduction and handling will be done in general accordance with the data management rules described in the following documents:

- *Portland Harbor Remedial Investigation/Feasibility Study, Final Remedial Investigation Report, Appendix A3 SCRA Database and Data Management* (EPA, 2016)
- *Portland Harbor RI/FS Round 3B Sediment Data Report, Appendix D, Summation Rules and SCRA Combo Database, Excel Flat File Format* (Integral, 2008)
- *Portland Harbor RI/FS Technical Memorandum: Guidelines for Data Averaging and Treatment of Non-detected Values for the Round 1 Database* (Kennedy/Jenks Consultants et al., 2004)

Data validation is described in Section 7.4

### 8.2.2 Data Summation Rules

The Portland Harbor RI/FS guidelines provide two sets of rules for summing data and retaining or modifying qualifiers (RI data set summation rules and baseline risk assessments and the background data set summation rules, which is consistent with the rules used in the FS), and for reducing the data to a single value per sample analyte. The summation rules apply to select analytical groups. The

“RI data rules” are intended for site characterization and generally use zero to represent non-detect values. The “RA/background data rules” are intended for risk assessment (RA) and determination of background concentrations and regional screening levels and generally use one-half the MDL to represent non-detect values. The RA/background data rules are more conservative in that they result in higher values than with the RI data rules, especially for low concentration samples. Data will be reported and mapped using only the RA/background data rules, which are the more conservative set of rules that have been carried forward to the Portland Harbor FS.

The data set summation rules are:

- Calculated totals are the sum of all detected concentrations, and non-detected results are included in the summation at one-half the MDL.
- If none of the analytes are detected for a given sample, then the highest MDL is used for the summation.
- Data qualifiers will be carried through the summation procedure. If all of the analytes were not detected, a “U” qualifier will be carried through to indicate that all results were reported as undetected. All calculated totals will be flagged with a “T” indicating they are mathematically derived values.

The Portland Harbor RI/FS guidelines also specify summation rules for select analytical groups, which include the same individual constituents regardless of which data rules are being used. A summary of data rules for UDSC analytes identified in Table 2 are presented below:

- Total PCBs congeners are calculated as the sum of individual congeners.
- Total low molecular weight PAHs (LPAH) are calculated using the concentrations for 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene. Total high molecular weight PAHs (HPAHs) are calculated using the concentrations for benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, benzofluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3,-cd)pyrene, and pyrene. Total PAHs are calculated by summing the LPAH and HPAH values.
- Total carcinogenic PAHs (cPAHs) were calculated as follows. A benzo(a)pyrene equivalent (BaPEq) concentration was calculated by multiplying the PAHs by their respective potency equivalent factors (PEFs), and summing the resulting concentrations. PAHs classified as carcinogenic are benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3,-c,d)pyrene. PEFs were assigned according to EPA’s *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* (EPA, 1993).
- Total DDx values are calculated with the concentrations of the six DDx compounds: 2,4'-DDD; 4,4'-DDD; 2,4'-DDE; 4,4' DDE; 2,4'-DDT; and 4,4'-DDT. Total DDD values are calculated with 2,4'-DDD and 4,4'-DDD; total DDE values are calculated with 2,4'-DDE and 4,4'-DDE; and total DDT was calculated by summing 2,4'-DDT and 4,4'-DDT.
- Total chlordanes are calculated as the sum of the following compounds: cis-chlordane, trans-chlordane, oxychlordane, cis-nonachlor, and trans-nonachlor.
- Total PCDD/Fs are calculated as the sum of dioxin and furan homologs: tetrachlorodibenzo-p-dioxins, pentachlorodibenzo-p-dioxins, hexachlorodibenzo-pdioxins, heptachlorodibenzo-

p-dioxins, octachlorodibenzo-p-dioxin, tetrachlorodibenzofurans, pentachlorodibenzofurans, hexachlorodibenzofurans, heptachlorodibenzofurans, and octachlorodibenzofuran.

- Dioxin and furan toxicity equivalency quotients (TEQs) are calculated using the 2005 World Health Organization consensus toxic equivalency factor (TEF) values for mammals (Van den Berg et al., 2006). TEQs were calculated as the sum of each congener concentration (or detection limit for non-detects) multiplied by the corresponding TEF value. When all of the congeners were not detected in a given sample, then the reported TEQ value was the highest congener detection limit multiplied time the TEF value.

## 9 Project Schedule and Reporting

### 9.1 Schedule

The target timeframe for the sampling event is early October 2017, completing field work no later than October 31, 2017. The actual start date will depend on EPA approval of the WP, receipt of necessary permits, and availability and scheduling of contractors. Weather, river flow conditions, equipment conditions, and other factors may affect the field schedule.

Laboratory analyses should be completed and electronic data reports provided to the PO for review and validation by approximately November 2017. The draft report is scheduled for submittal to the EPA in April 2018. The final field and data report will be completed by June 2018.

### 9.2 Reporting

A draft and final field and data report will be prepared for the URSC. This report is anticipated to include the following:

- Summary of sampling approach and objectives.
- Summary of field sampling activities, sample collection procedures, and any deviations from the WP.
- Maps showing actual sampling stations.
- Analyte concentration maps of PCBs including existing sediment data presented in the Portland Harbor FS sediment database.
- Tables providing analytical results.
- Grab sample description logs and representative photographs collected during the URSC sampling event.
- Data validation report will be appended to the report.
- Laboratory reports will be provided as PDFs on a CD or DVD.

## 10 References

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**Table 1. Project Objectives and Basis for Sample Selection**

Area of Interest	Composite Area ID	Sample Collection Method		Basis for Sample Selection
		Number of Discrete Samples in Composite	Access	
Johnson Creek Confluence	RM18.35E	10	Shore	Multiple potential point and non-point sources of contamination may be present in Johnson Creek. A historical carp sample collected nearby in the Willamette River had elevated levels of PCBs and pesticides. Sediment data have not previously been collected in this area for Portland Harbor COCs. River bottom substrate appears to be composed of some fines.
Kellogg Creek Confluence and WWTP	RM18.45E	10	Shore/Vessel	Multiple potential point and non-point sources of contamination may be present in Kellogg Creek and a WWTP discharges at this location. A historical carp sample collected nearby in the Willamette River had elevated levels of PCBs and pesticides. Sediment data have not previously been collected in this area for Portland Harbor COCs. River bottom substrate appears to be composed of some fines.
Tryon Creek Confluence	RM20.0W	5	Vessel	Tyron Creek discharges in this area and USGS sediment sampling indicates accumulation of contaminants (mostly pharmaceuticals) in the vicinity. Further, the Tryon Creek WWTP discharges at this location. The area appears to be depositional. The area warrants further evaluation for additional contaminants.
Lake Oswego Industrial Area	RM20.1W	10	Vessel	Multiple DEQ cleanup sites are in this area, including ECSI 71 Martin Electronic where a release of PCBs resulted in significant soil contamination. While the site was remediated, no historical sample collection in-water has been identified in this area and the river substrate appears to have some areas of sand and muddy sand, indicating sufficient fines are available to accumulate potential contamination.
Oak Lodge Water Reclamation Facility	RM20.1E	5	Shore/Vessel	A small mouth bass sample collected approximately 1 mile upstream had elevated PCBs and DDX. No historical samples were collected in this area. A WWTP discharges in this vicinity.
Forest Creek Confluence	RM20.4E	5	Shore/Vessel	A small mouth bass sample collected approximately 1 mile upstream had elevated PCBs and DDX. No historical samples were collected in this area. Forest Creek discharges a small lake, River Forest Lake, which discharges to the Willamette River.
Lake Oswego Discharge	RM20.9W	10	Vessel	Lake Oswego discharges at this location and there appears to be an accumulation of fines in the area. No sediment data are available in this area.
Goat Island West - OPTIONAL	RM24.4W	10	Vessel	Marginally elevated PCBs and dioxins were detected at approximately RM 24.4. While the western shore of the river is currently entirely single family housing with a few docking/harbor areas, the anomalously high concentrations may warrant further characterization, particularly because the area appears to accumulate a higher percentage of fines. This location is designated as optional, indicating that the area will be characterized if enough funding is available.



**Table 1. Project Objectives and Basis for Sample Selection**

Area of Interest	Composite Area ID	Sample Collection Method		Basis for Sample Selection
		Number of Discrete Samples in Composite	Access	
Clackamas River Confluence	RM24.7E	10	Vessel	The Clackamas River discharges to the Willamette River in this location and there is some accumulation of sand on the east shore. While historical samples show only a minimally elevated concentration of PAHs, a comprehensive analysis was not conducted (e.g., PCBs were not analyzed).
Downstream of Willamette Falls	RM25.2E	10	Vessel	Multiple outfalls, a WWTP, and Abernathy Creek discharge in this area. Further, multiple DEQ cleanup sites are located on both shores and upriver. While river bottom substrate has historically been described as hard ground, an area of river widening and potential lower velocities and settling of sediment is targeted for characterization. If sufficient fines are available for sampling at the selected area, field reconnaissance will be conducted to find accumulated sediment between RMs 25 and 26 for sampling and analysis.

Table 2. Analytes, Analytical Methods, Detection Limits, Method Reporting Limits, and Portland Harbor Cleanup Levels in Sediment Samples

Analyte	Unit <sup>1</sup>	Analytical Method	PHSS Cleanup Level	Typical Values <sup>2,3</sup>	
				MDL	MRL
<b>Conventionals</b>					
Total Organic Carbon	%	PSEP	--	0.07	0.2
Grain Size - Condensed Breakout	%	ASTM DM22M	--	NA	NA
Total Solids	NA	PSEP	--	NA	NA
<b>Metals</b>					
Arsenic	mg/kg	EPA 6020A	3	0.2	0.5
Cadmium	mg/kg	EPA 6020A	0.51	0.009	0.02
Chromium	mg/kg	EPA 6020A	--	0.07	0.2
Copper	mg/kg	EPA 6020A	359	0.04	0.1
Lead	mg/kg	EPA 6020A	196	0.02	0.05
Manganese	mg/kg	EPA 6020A	--	0.02	0.05
Mercury	mg/kg	EPA 7471A	0.085	0.002	0.02
Nickel	mg/kg	EPA 6020A	--	0.04	0.2
Zinc	mg/kg	EPA 6020A	459	0.2	0.5
<b>Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans (PCDD/Fs)</b>					
1,2,3,4,6,7,8-HpCDD	µg/Kg	EPA 1613B	--	0.00011	0.05
1,2,3,4,6,7,8-HpCDF	µg/Kg	EPA 1613B	--	0.00009	0.05
1,2,3,4,7,8,9-HpCDF	µg/Kg	EPA 1613B	--	0.00012	0.05
1,2,3,4,7,8-HxCDD	µg/Kg	EPA 1613B	--	0.00013	0.05
1,2,3,4,7,8-HxCDF	µg/Kg	EPA 1613B	0.0004	0.0001	0.05
1,2,3,6,7,8-HxCDD	µg/Kg	EPA 1613B	--	0.00011	0.05
1,2,3,6,7,8-HxCDF	µg/Kg	EPA 1613B	--	0.0001	0.05
1,2,3,7,8,9-HxCDD	µg/Kg	EPA 1613B	--	0.00011	0.05
1,2,3,7,8,9-HxCDF	µg/Kg	EPA 1613B	--	0.00013	0.05
1,2,3,7,8-PeCDD	µg/Kg	EPA 1613B	0.0002	0.00015	0.05
1,2,3,7,8-PeCDF	µg/Kg	EPA 1613B	--	0.0001	0.05
2,3,4,6,7,8-HxCDF	µg/Kg	EPA 1613B	--	0.00011	0.05
2,3,4,7,8-PeCDF	µg/Kg	EPA 1613B	0.0003	0.00011	0.05
2,3,7,8-TCDD	µg/Kg	EPA 1613B	0.0002	0.0001	0.01
2,3,7,8-TCDF	µg/Kg	EPA 1613B	0.0004	0.00011	0.01
Dioxin/Furan TEQ (2,3,7,8-TCDD Eq)	µg/Kg	EPA 1613B	0.01	--	--
Total PCDD/Fs	µg/Kg	EPA 1613B	--	--	--
<b>Petroleum</b>					
Diesel Range Hydrocarbons (with Silica gel clean-up)	mg/kg	NWTPH-Dx	91	1.6	25
<b>Pesticides</b>					
2,4'-DDD	µg/Kg	EPA 1699M	--	0.063	0.1
2,4'-DDE	µg/Kg	EPA 1699M	--	0.079	0.1
2,4'-DDT	µg/Kg	EPA 1699M	--	0.094	0.1
4,4'-DDD	µg/Kg	EPA 1699M	--	0.035	0.1
4,4'-DDE	µg/Kg	EPA 1699M	--	0.07	0.1
4,4'-DDT	µg/Kg	EPA 1699M	--	0.047	0.1
Total DDx <sup>b</sup>	µg/Kg	EPA 1699M	6.1	--	--
Total DDD	µg/Kg	EPA 1699M	114	--	--
Total DDE	µg/Kg	EPA 1699M	226	--	--
Total DDT	µg/Kg	EPA 1699M	246	--	--
Cis-Chlordane	µg/Kg	EPA 1699M	--	0.062	0.1
Cis-Nonachlor	µg/Kg	EPA 1699M	--	0.097	0.1
Trans-Chlordane	µg/Kg	EPA 1699M	--	0.064	0.1
Trans-Nonachlor	µg/Kg	EPA 1699M	--	0.058	0.1
Total Chlordanes <sup>c</sup>	µg/Kg	EPA 1699M	1.4	--	--
Aldrin	µg/Kg	EPA 1699M	2	0.079	0.1
alpha-BHC	µg/Kg	EPA 1699M	--	0.041	0.1
beta-BHC	µg/Kg	EPA 1699M	--	0.061	0.1
Chlorpyrifos	µg/Kg	EPA 1699M	--	0.077	0.1
delta-BHC	µg/Kg	EPA 1699M	--	0.097	0.1
Dieldrin	µg/Kg	EPA 1699M	0.07	0.077	0.2
Endosulfan I	µg/Kg	EPA 1699M	--	0.088	0.2
Endosulfan II	µg/Kg	EPA 1699M	--	0.15	0.2
Endosulfan Sulfate	µg/Kg	EPA 1699M	--	0.061	0.1
Endrin	µg/Kg	EPA 1699M	--	0.073	0.2
Endrin Aldehyde	µg/Kg	EPA 1699M	--	0.1	0.2
Endrin Ketone	µg/Kg	EPA 1699M	--	0.071	0.1
Gamma-Hexachlorocyclohexane [gamma-HCH (Lindane)]	µg/Kg	EPA 1699M	5	0.031	0.1
Heptachlor	µg/Kg	EPA 1699M	--	0.039	0.1
Heptachlor Epoxide	µg/Kg	EPA 1699M	--	0.073	0.1
Hexachlorobenzene	µg/Kg	EPA 1699M	--	0.092	0.1
Isodrin	µg/Kg	EPA 1699M	--	0.069	0.2
Methoxychlor	µg/Kg	EPA 1699M	--	0.019	0.1
Mirex	µg/Kg	EPA 1699M	--	0.045	0.1

**Table 2. Analytes, Analytical Methods, Detection Limits, Method Reporting Limits, and Portland Harbor Cleanup Levels in Sediment Samples**

Analyte	Unit <sup>1</sup>	Analytical Method	PHSS Cleanup Level	Typical Values <sup>2,3</sup>	
				MDL	MRL
Octachlorostyrene	µg/Kg	EPA 1699M		0.058	0.1
Oxychlorodane	µg/Kg	EPA 1699M	--	0.1	0.1
<b>SVOCs/Pesticides</b>					
Hexachlorobenzene	µg/Kg	EPA 1699M	--	0.092	0.1
<b>Polycyclic Aromatic Hydrocarbons</b>					
2-Methylnaphthalene	µg/Kg	EPA 8270 D LL	--	2.8	10
Acenaphthene	µg/Kg	EPA 8270 D LL	--	3.2	10
Acenaphthylene	µg/Kg	EPA 8270 D LL	--	2.6	10
Anthracene	µg/Kg	EPA 8270 D LL	--	3.2	10
Benzo(a)anthracene	µg/Kg	EPA 8270 D LL	--	3.6	10
Benzo(a)pyrene	µg/Kg	EPA 8270 D LL	--	3.6	10
Benzo(b)fluoranthene	µg/Kg	EPA 8270 D LL	--	3.4	10
Benzo(g,h,i)perylene	µg/Kg	EPA 8270 D LL	--	3.7	10
Benzo(k)fluoranthene	µg/Kg	EPA 8270 D LL	--	4	10
Chrysene	µg/Kg	EPA 8270 D LL	--	4.1	10
Dibenzo(a,h)anthracene	µg/Kg	EPA 8270 D LL	--	3	10
Fluoranthene	µg/Kg	EPA 8270 D LL	--	3.7	10
Fluorene	µg/Kg	EPA 8270 D LL	--	3.3	10
Indeno(1,2,3-cd)pyrene	µg/Kg	EPA 8270 D LL	--	3.2	10
Naphthalene	µg/Kg	EPA 8270 D LL	--	2.9	10
Phenanthrene	µg/Kg	EPA 8270 D LL	--	3.6	10
Pyrene	µg/Kg	EPA 8270 D LL	--	3.7	10
Total PAH	µg/Kg	EPA 8270 D LL	23000	--	--
Total cPAH (BaP Eq)	µg/Kg	EPA 8270 D LL	106 <sup>4</sup>	--	--
<b>Phenols</b>					
Pentachlorophenol	µg/Kg	EPA 8270 D LL	--	5.3	100
<b>Phthalates</b>					
Bis(2-Ethylhexyl) Phthalate	µg/Kg	EPA 8270 D LL	135	8.9	100
<b>Polybrominated Diphenyl Ethers (PBDEs)</b>					
PBDE 100	µg/Kg	8270D PBDE	--	0.014	0.1
PBDE 128	µg/Kg	8270D PBDE	--	0.0099	0.1
PBDE 138	µg/Kg	8270D PBDE	--	0.016	0.1
PBDE 153	µg/Kg	8270D PBDE	--	0.0087	0.1
PBDE 154	µg/Kg	8270D PBDE	--	0.0078	0.1
PBDE 17	µg/Kg	8270D PBDE	--	0.023	0.1
PBDE 183	µg/Kg	8270D PBDE	--	0.013	0.1
PBDE 190	µg/Kg	8270D PBDE	--	0.02	0.1
PBDE 203	µg/Kg	8270D PBDE	--	0.029	0.1
PBDE 206	µg/Kg	8270D PBDE	--	0.031	1
PBDE 209	µg/Kg	8270D PBDE	--	0.026	1
PBDE 28	µg/Kg	8270D PBDE	--	0.024	0.1
PBDE 47	µg/Kg	8270D PBDE	--	0.029	0.1
PBDE 66	µg/Kg	8270D PBDE	--	0.019	0.1
PBDE 71	µg/Kg	8270D PBDE	--	0.015	0.1
PBDE 85	µg/Kg	8270D PBDE	--	0.04	0.1
PBDE 99	µg/Kg	8270D PBDE	--	0.03	0.1
<b>Polychlorinated Biphenyls (PCBs)</b>					
2-MonoCB-(1)	µg/Kg	EPA 1668B	--	0.0002	0.01
3-MonoCB-(2)	µg/Kg	EPA 1668B	--	0.0001	0.01
4-MonoCB-(3)	µg/Kg	EPA 1668B	--	0.0002	0.01
2,2'-DiCB-(4)	µg/Kg	EPA 1668B	--	0.0004	0.01
2,3-DiCB-(5)	µg/Kg	EPA 1668B	--	0.0004	0.01
2,3'-DiCB-(6)	µg/Kg	EPA 1668B	--	0.0003	0.01
2,4-DiCB-(7)	µg/Kg	EPA 1668B	--	0.0003	0.01
2,4'-DiCB-(8)	µg/Kg	EPA 1668B	--	0.0003	0.01
2,5-DiCB-(9)	µg/Kg	EPA 1668B	--	0.0003	0.01
2,6-DiCB-(10)	µg/Kg	EPA 1668B	--	0.0004	0.01
3,3'-DiCB-(11)	µg/Kg	EPA 1668B	--	0.0004	0.01
DiCB-(12)+(13)	µg/Kg	EPA 1668B	--	0.0004	0.02
3,5-DiCB-(14)	µg/Kg	EPA 1668B	--	0.0003	0.01
4,4'-DiCB-(15)	µg/Kg	EPA 1668B	--	0.0006	0.01
2,2',3'-TriCB-(16)	µg/Kg	EPA 1668B	--	0.0007	0.01
2,2',4'-TriCB-(17)	µg/Kg	EPA 1668B	--	0.0004	0.01
TriCB-(18)+(30)	µg/Kg	EPA 1668B	--	0.0004	0.02
2,2',6'-TriCB-(19)	µg/Kg	EPA 1668B	--	0.0004	0.01
TriCB-(20) + (28)	µg/Kg	EPA 1668B	--	0.0007	0.02
TriCB-(21)+(33)	µg/Kg	EPA 1668B	--	0.0007	0.02

Table 2. Analytes, Analytical Methods, Detection Limits, Method Reporting Limits, and Portland Harbor Cleanup Levels in Sediment Samples

Analyte	Unit <sup>1</sup>	Analytical Method	PHSS Cleanup Level	Typical Values <sup>2,3</sup>	
				MDL	MRL
234'-TriCB-(22)	µg/Kg	EPA 1668B	--	0.0007	0.01
235'-TriCB-(23)	µg/Kg	EPA 1668B	--	0.0007	0.01
236'-TriCB-(24)	µg/Kg	EPA 1668B	--	0.0003	0.01
23'4'-TriCB-(25)	µg/Kg	EPA 1668B	--	0.0007	0.01
TriCB-(26)+(29)	µg/Kg	EPA 1668B	--	0.0007	0.02
23'6'-TriCB-(27)	µg/Kg	EPA 1668B	--	0.0003	0.01
24'5'-TriCB-(31)	µg/Kg	EPA 1668B	--	0.0006	0.01
24'6'-TriCB-(32)	µg/Kg	EPA 1668B	--	0.0003	0.01
23'5'-TriCB-(34)	µg/Kg	EPA 1668B	--	0.0007	0.01
33'4'-TriCB-(35)	µg/Kg	EPA 1668B	--	0.0007	0.01
33'5'-TriCB-(36)	µg/Kg	EPA 1668B	--	0.0020	0.01
344'-TriCB-(37)	µg/Kg	EPA 1668B	--	0.0010	0.01
345'-TriCB-(38)	µg/Kg	EPA 1668B	--	0.0007	0.01
34'5'-TriCB-(39)	µg/Kg	EPA 1668B	--	0.0006	0.01
TetraCB-(40)+(41)+(71)	µg/Kg	EPA 1668B	--	0.0006	0.03
22'34'-TetraCB-(42)	µg/Kg	EPA 1668B	--	0.0007	0.01
22'35'-TetraCB-(43)	µg/Kg	EPA 1668B	--	0.0008	0.01
TetraCB-(44)+(47)+(65)	µg/Kg	EPA 1668B	--	0.0006	0.03
TetraCB-(45)+(51)	µg/Kg	EPA 1668B	--	0.0006	0.02
22'36'-TetraCB-(46)	µg/Kg	EPA 1668B	--	0.0008	0.01
22'45'-TetraCB-(48)	µg/Kg	EPA 1668B	--	0.0006	0.01
TetraCB-(49)+TetraCB-(69)	µg/Kg	EPA 1668B	--	0.0005	0.02
TetraCB-(50)+(53)	µg/Kg	EPA 1668B	--	0.0006	0.02
22'55'-TetraCB-(52)	µg/Kg	EPA 1668B	--	0.0006	0.01
22'66'-TetraCB-(54)	µg/Kg	EPA 1668B	--	0.0004	0.01
233'4'-TetraCB-(55)	µg/Kg	EPA 1668B	--	0.0030	0.01
233'4'-Tetra CB(56)	µg/Kg	EPA 1668B	--	0.0010	0.01
233'5'-TetraCB-(57)	µg/Kg	EPA 1668B	--	0.0010	0.01
233'5'-TetraCB-(58)	µg/Kg	EPA 1668B	--	0.0009	0.01
TetraCB-(59)+(62)+(75)	µg/Kg	EPA 1668B	--	0.0005	0.03
2344'-TetraCB -(60)	µg/Kg	EPA 1668B	--	0.0010	0.01
TetraCB-(61)+(70)+(74)+(76)	µg/Kg	EPA 1668B	--	0.0010	0.04
234'5'-TetraCB-(63)	µg/Kg	EPA 1668B	--	0.0009	0.01
234'6'-TetraCB-(64)	µg/Kg	EPA 1668B	--	0.0005	0.01
23'44'-TetraCB-(66)	µg/Kg	EPA 1668B	--	0.0009	0.01
23'45'-TetraCB-(67)	µg/Kg	EPA 1668B	--	0.0009	0.01
23'45'-TetraCB-(68)	µg/Kg	EPA 1668B	--	0.0009	0.01
23'55'-TetraCB-(72)	µg/Kg	EPA 1668B	--	0.0009	0.01
23'5'6'-TetraCB-(73)	µg/Kg	EPA 1668B	--	0.0004	0.01
33'44'-TetraCB-(77)	µg/Kg	EPA 1668B	--	0.0012	0.01
33'45'-TetraCB-(78)	µg/Kg	EPA 1668B	--	0.0010	0.01
33'45'-TetraCB(79)	µg/Kg	EPA 1668B	--	0.0008	0.01
33'55'-TetraCB-(80)	µg/Kg	EPA 1668B	--	0.0009	0.01
344'5'-TetraCB-(81)	µg/Kg	EPA 1668B	--	0.0012	0.01
22'33'4'-PentaCB-(82)	µg/Kg	EPA 1668B	--	0.0014	0.01
PentaCB-(83)+(99)	µg/Kg	EPA 1668B	--	0.0013	0.02
22'33'6'-PentaCB-(84)	µg/Kg	EPA 1668B	--	0.0015	0.01
PentaCB-(85)+(116)+(117)	µg/Kg	EPA 1668B	--	0.0011	0.03
PentaCB-(86)(87)(97)(109)(119)(125)	µg/Kg	EPA 1668B	--	0.0011	0.06
PentaCB-(88)+(91)	µg/Kg	EPA 1668B	--	0.0012	0.02
22'346'-PentaCB-(89)	µg/Kg	EPA 1668B	--	0.0013	0.01
PentaCB-(90)+(101)+(113)	µg/Kg	EPA 1668B	--	0.0011	0.03
22'355'-PentaCB-(92)	µg/Kg	EPA 1668B	--	0.0013	0.01
PentaCB-(93)+(98)+(100)+(102)	µg/Kg	EPA 1668B	--	0.0013	0.04
22'356'-PentaCB-(94)	µg/Kg	EPA 1668B	--	0.0013	0.01
22'35'6'-PentaCB-(95)	µg/Kg	EPA 1668B	--	0.0012	0.01
22'366'-PentaCB-(96)	µg/Kg	EPA 1668B	--	0.0003	0.01
22'45'6'-PentaCB-(103)	µg/Kg	EPA 1668B	--	0.0011	0.01
22'466'-PentaCB-(104)	µg/Kg	EPA 1668B	--	0.0031	0.01
233'44'-PentaCB-(105)	µg/Kg	EPA 1668B	--	0.0008	0.01
233'45'-PentaCB-(106)	µg/Kg	EPA 1668B	--	0.0007	0.01
233'4'5'-PentaCB-(107)	µg/Kg	EPA 1668B	--	0.0006	0.01
PentaCB-(108)+(124)	µg/Kg	EPA 1668B	--	0.0007	0.02
PentaCB-(110)+(115)	µg/Kg	EPA 1668B	--	0.0010	0.02
233'55'-PentaCB-(111)	µg/Kg	EPA 1668B	--	0.0009	0.01
233'56'-PentaCB-(112)	µg/Kg	EPA 1668B	--	0.0009	0.01
2344'5'-PentaCB-(114)	µg/Kg	EPA 1668B	--	0.0008	0.01

**Table 2. Analytes, Analytical Methods, Detection Limits, Method Reporting Limits, and Portland Harbor Cleanup Levels in Sediment Samples**

Analyte	Unit <sup>1</sup>	Analytical Method	PHSS Cleanup Level	Typical Values <sup>2,3</sup>	
				MDL	MRL
23'44'5'-PentaCB-(118)	µg/Kg	EPA 1668B	--	0.0008	0.01
23'45'5'-PentaCB-(120)	µg/Kg	EPA 1668B	--	0.0009	0.01
23'45'6'-PentaCB-(121)	µg/Kg	EPA 1668B	--	0.0009	0.01
233'4'5'-PentaCB-(122)	µg/Kg	EPA 1668B	--	0.0007	0.01
23'44'5'-PentaCB-(123)	µg/Kg	EPA 1668B	--	0.0008	0.01
33'44'5'-PentaCB-(126)	µg/Kg	EPA 1668B	--	0.0008	0.01
33'45'5'-PentaCB-(127)	µg/Kg	EPA 1668B	--	0.0007	0.01
HexaCB-(128)+(166)	µg/Kg	EPA 1668B	--	0.0016	0.02
HexaCB-(129)+(138)+(163)	µg/Kg	EPA 1668B	--	0.0018	0.03
22'33'45'-HexaCB-(130)	µg/Kg	EPA 1668B	--	0.0020	0.01
22'33'46'-HexaCB-(131)	µg/Kg	EPA 1668B	--	0.0023	0.01
22'33'46'-HexaCB-(132)	µg/Kg	EPA 1668B	--	0.0020	0.01
22'33'55'-HexaCB-(133)	µg/Kg	EPA 1668B	--	0.0019	0.01
HexaCB-(134)+(143)	µg/Kg	EPA 1668B	--	0.0021	0.02
HexaCB-(135)+(151)	µg/Kg	EPA 1668B	--	0.0003	0.02
22'33'66'-HexaCB-(136)	µg/Kg	EPA 1668B	--	0.0003	0.01
22'344'5'-HexaCB-(137)	µg/Kg	EPA 1668B	--	0.0018	0.01
HexaCB-(139)+(140)	µg/Kg	EPA 1668B	--	0.0017	0.02
22'3455'-HexaCB-(141)	µg/Kg	EPA 1668B	--	0.0019	0.01
22'3456'-HexaCB-(142)	µg/Kg	EPA 1668B	--	0.0020	0.01
22'345'6'-HexaCB-(144)	µg/Kg	EPA 1668B	--	0.0003	0.01
22'3466'-HexaCB-(145)	µg/Kg	EPA 1668B	--	0.0003	0.01
22'34'55'-HexaCB-(146)	µg/Kg	EPA 1668B	--	0.0017	0.01
HexaCB-(147)+(149)	µg/Kg	EPA 1668B	--	0.0017	0.02
22'34'56'-HexaCB-(148)	µg/Kg	EPA 1668B	--	0.0003	0.01
22'34'66'-HexaCB-(150)	µg/Kg	EPA 1668B	--	0.0002	0.01
22'3566'-HexaCB-(152)	µg/Kg	EPA 1668B	--	0.0003	0.01
HexaCB-(153)+(168)	µg/Kg	EPA 1668B	--	0.0014	0.02
22'44'56'-HexaCB-(154)	µg/Kg	EPA 1668B	--	0.0003	0.01
22'44'66'-HexaCB-(155)	µg/Kg	EPA 1668B	--	0.0003	0.01
HexaCB-(156)+(157)	µg/Kg	EPA 1668B	--	0.0013	0.02
233'44'6'-HexaCB-(158)	µg/Kg	EPA 1668B	--	0.0013	0.01
233'455'-HexaCB-(159)	µg/Kg	EPA 1668B	--	0.0011	0.01
233'456'-HexaCB-(160)	µg/Kg	EPA 1668B	--	0.0014	0.01
233'45'6'-HexaCB-(161)	µg/Kg	EPA 1668B	--	0.0014	0.01
233'4'55'-HexaCB-(162)	µg/Kg	EPA 1668B	--	0.0011	0.01
233'4'5'6'-HexaCB-(164)	µg/Kg	EPA 1668B	--	0.0015	0.01
233'55'6'-HexaCB-(165)	µg/Kg	EPA 1668B	--	0.0015	0.01
23'44'55'-HexaCB-(167)	µg/Kg	EPA 1668B	--	0.0013	0.01
33'44'55'-HexaCB-(169)	µg/Kg	EPA 1668B	--	0.0014	0.01
22'33'44'5'-HeptaCB-(170)	µg/Kg	EPA 1668B	--	0.0012	0.01
HeptaCB-(171)+(173)	µg/Kg	EPA 1668B	--	0.0013	0.02
22'33'455'-HeptaCB-(172)	µg/Kg	EPA 1668B	--	0.0013	0.01
22'33'456'-HeptaCB-(174)	µg/Kg	EPA 1668B	--	0.0012	0.01
22'33'45'6'-HeptaCB-(175)	µg/Kg	EPA 1668B	--	0.0004	0.01
22'33'466'-HeptaCB-(176)	µg/Kg	EPA 1668B	--	0.0003	0.01
22'33'45'6'-HeptaCB-(177)	µg/Kg	EPA 1668B	--	0.0013	0.01
22'33'55'6'-HeptaCB-(178)	µg/Kg	EPA 1668B	--	0.0004	0.01
22'33'566'-HeptaCB-(179)	µg/Kg	EPA 1668B	--	0.0003	0.01
HeptaCB-(180)+(193)	µg/Kg	EPA 1668B	--	0.0010	0.02
22'344'56'-HeptaCB-(181)	µg/Kg	EPA 1668B	--	0.0011	0.01
22'344'56'-HeptaCB-(182)	µg/Kg	EPA 1668B	--	0.0019	0.01
22'344'5'6'-HeptaCB-(183)	µg/Kg	EPA 1668B	--	0.0011	0.01
22'344'66'-HeptaCB-(184)	µg/Kg	EPA 1668B	--	0.0003	0.01
22'3455'6'-HeptaCB-(185)	µg/Kg	EPA 1668B	--	0.0012	0.01
22'34566'-HeptaCB-(186)	µg/Kg	EPA 1668B	--	0.0003	0.01
22'34'55'6'-HeptaCB-(187)	µg/Kg	EPA 1668B	--	0.0004	0.01
22'34'566'-HeptaCB-(188)	µg/Kg	EPA 1668B	--	0.0004	0.01
233'44'55'-HeptaCB-(189)	µg/Kg	EPA 1668B	--	0.0015	0.01
233'44'56'-HeptaCB-(190)	µg/Kg	EPA 1668B	--	0.0010	0.01
233'44'5'6'-HeptaCB-(191)	µg/Kg	EPA 1668B	--	0.0009	0.01
233'455'6'-HeptaCB-(192)	µg/Kg	EPA 1668B	--	0.0010	0.01
22'33'44'55'-OctaCB-(194)	µg/Kg	EPA 1668B	--	0.0025	0.01
22'33'44'56'-OctaCB-(195)	µg/Kg	EPA 1668B	--	0.0028	0.01
22'33'44'56'-OctaCB-(196)	µg/Kg	EPA 1668B	--	0.0012	0.01
22'33'44'66'-OctaCB-(197)	µg/Kg	EPA 1668B	--	0.0008	0.01
OctaCB-(198)+(199)	µg/Kg	EPA 1668B	--	0.0012	0.02

**Table 2. Analytes, Analytical Methods, Detection Limits, Method Reporting Limits, and Portland Harbor Cleanup Levels in Sediment Samples**

Analyte	Unit <sup>1</sup>	Analytical Method	PHSS Cleanup Level	Typical Values <sup>2,3</sup>	
				MDL	MRL
22'33'4566'-OctaCB-(200)	µg/Kg	EPA 1668B	--	0.0009	0.01
22'33'45'66'-OctaCB-(201)	µg/Kg	EPA 1668B	--	0.0008	0.01
22'33'55'66'-OctaCB-(202)	µg/Kg	EPA 1668B	--	0.0011	0.01
22'344'55'6'-OctaCB-(203)	µg/Kg	EPA 1668B	--	0.0011	0.01
22'344'566'-OctaCB-(204)	µg/Kg	EPA 1668B	--	0.0009	0.01
233'44'55'6'-OctaCB-(205)	µg/Kg	EPA 1668B	--	0.0022	0.01
22'33'44'55'6'-NonaCB-(206)	µg/Kg	EPA 1668B	--	0.0016	0.01
22'33'44'566'-NonaCB-(207)	µg/Kg	EPA 1668B	--	0.0012	0.01
22'33'455'66'-NonaCB-(208)	µg/Kg	EPA 1668B	--	0.0016	0.01
DecaCB-(209)	µg/Kg	EPA 1668B	--	0.0014	0.01
Monochlorobiphenyls	µg/Kg	EPA 1668B	--	--	--
Dichlorobiphenyls	µg/Kg	EPA 1668B	--	--	--
Trichlorobiphenyls	µg/Kg	EPA 1668B	--	--	--
Tetrachlorobiphenyls	µg/Kg	EPA 1668B	--	--	--
Pentachlorobiphenyls	µg/Kg	EPA 1668B	--	--	--
Hexachlorobiphenyls	µg/Kg	EPA 1668B	--	--	--
Heptachlorobiphenyls	µg/Kg	EPA 1668B	--	--	--
Octachlorobiphenyls	µg/Kg	EPA 1668B	--	--	--
Nonachlorobiphenyls	µg/Kg	EPA 1668B	--	--	--
Decachlorobiphenyl	µg/Kg	EPA 1668B	--	--	--
Total PCB Congeners	µg/Kg	EPA 1668B	9	--	--

**Notes**

1 Units are provided on a dry-weight basis.

2 The MDLs/MRLs listed are consistent with recent sediment investigations in Portland Harbor. The contract lab should provide updated

3 Detection and reporting limits based on clean sample. Elevated target and non target compounds can lead to raised limits.

% = percent

ng/kg = nanograms per kilogram

mg/kg = milligrams per kilogram

µg/kg = micrograms per kilogram

MDL = method detection limit

MRL = method reporting limit

PAH = polycyclic aromatic hydrocarbon

PHSS= Portland Harbor Superfund Site

SVOC = semivolatile organic compound

TBD = to be determined

VOC = volatile organic compound

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

**Table 3. Sample Containers, Preservation, Holding Times, and Sample Volume**

Container <sup>1</sup> Type	Analysis	Method	Preservation	Holding Time (until extraction or frozen archival)	Lab Sample Size <sup>2</sup>
<b>Sediment Samples</b>					
WMG	Grain-Size	ASTM D422M	4°C	6 m <sup>3</sup>	1000 g
WMG	Total organic carbon	PSEP	4°C	28 d <sup>4</sup>	2 g
WMG	Metals and total solids	EPA 6020A	4°C	6 m <sup>4</sup>	20 g
WMG	Mercury	EPA 7471A	4°C	28 d <sup>4</sup>	10 g
WMG	Diesel Range Hydrocarbons (with Silica gel clean-up)	NWTPH-Dx	4°C	14 d <sup>4</sup>	30 g
WMG	PAHs, SVOCs, Phenols, and Phthalates	EPA 8270 D LL	4°C	14 d <sup>4</sup>	30 g
WMG	Organochlorine Pesticides	EPA 1699M	4°C	14 d <sup>4</sup>	30 g
WMG	PBDEs	8270D PBDE	4°C	14 d <sup>4</sup>	30 g
WMG	Polychlorinated Dibenzo-p- dioxins and Polychlorinated Dibenzofurans (PCDD/Fs)	EPA 1613B	≤ -10°C	1 y	30 g
WMG	PCB Congeners	EPA 1668B	≤ -10°C	1 y	30 g
WMG	Archival	Frozen	≤ -10°C	1 y <sup>4</sup>	TBD
<b>Minimum Sample Mass Required (g)</b>					<b>212</b>
<b>Equipment Rinsate Blanks</b>					
PC	Total organic carbon	PSEP	Sulfuric acid to pH <2; 4°C	28 d	250 mL
HDPE	Metals	EPA 6020A	HNO <sub>3</sub> to pH<2; 4°C	6 m	100 ml
HDPE	Mercury	EPA 7471A	HNO <sub>3</sub> to pH<2; 4°C	28 d	100 ml
AG	Diesel Range Hydrocarbons (with Silica gel clean-up)	NWTPH-Dx	HCl to pH 2; 4°C	14 d	500 mL
AG	PAHs, SVOCs, Phenols, and Phthalates	EPA 8270 D LL	Dark; 4°C	7 d/40 d <sup>5</sup>	1 L
AG	Organochlorine Pesticides	EPA 1699M	Dark; 4°C	7 d/40 d <sup>5</sup>	1 L
AG	PBDEs	8270D PBDE	Dark; 4°C	7 d/40 d <sup>5</sup>	1 L
AG	PCDD/Fs	EPA 1613B	Dark; 4°C	1 y	1 L
AG	PCB congeners	EPA 1668B	Sulfuric acid to pH 2-3; 4°C	1 y	1 L

**Notes:**

AG = amber glass

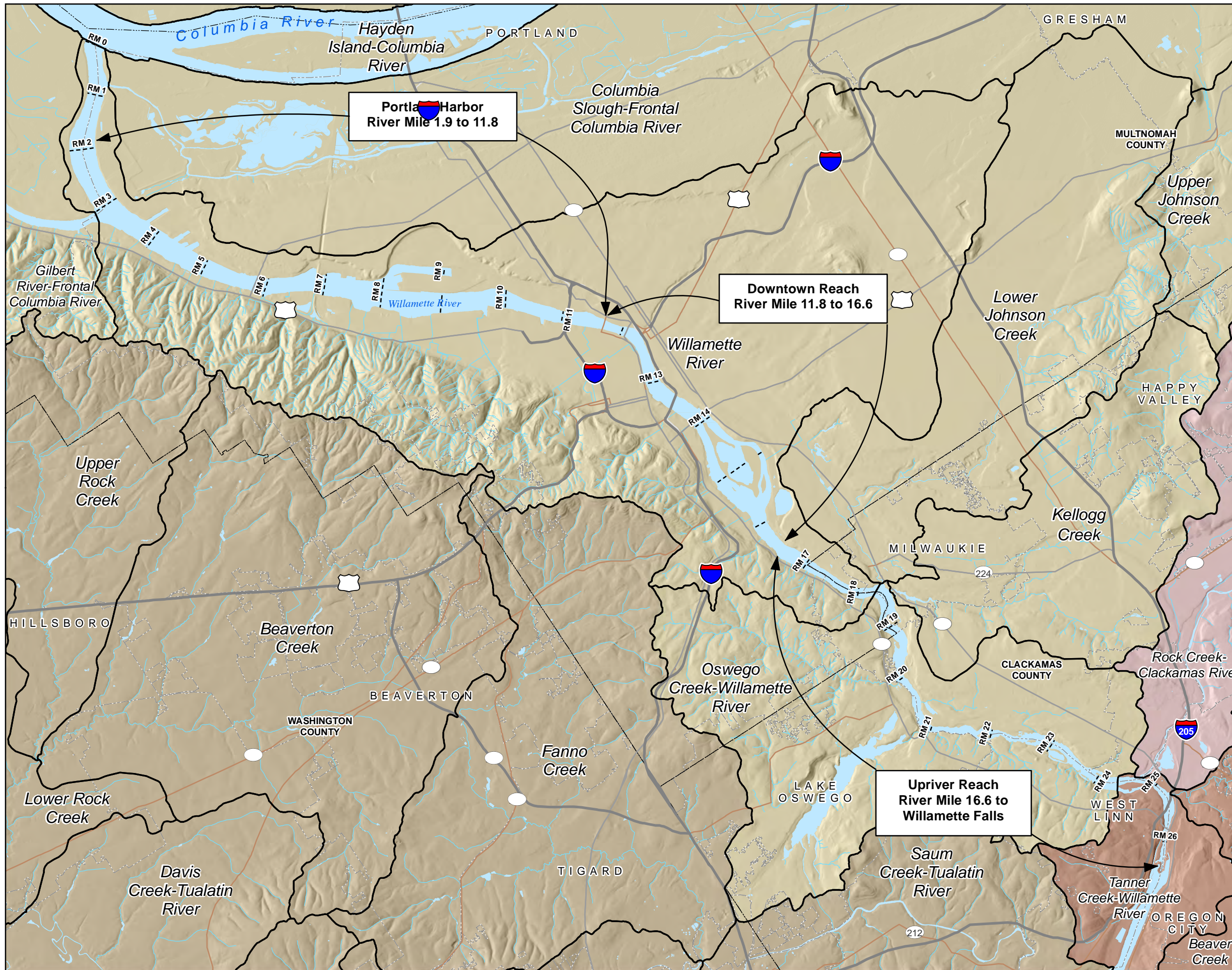
HDPE = high-density polyethylene

PC = polycarbonate

WMG = wide-mouth glass

<sup>1</sup> Size and number of bottles may be modified by lab.<sup>2</sup> Collection of approximately 3x normal sample size listed will be necessary for laboratory QC analyses.<sup>3</sup> Samples must not be frozen or dried prior to analysis, as either process may change the particle size distribution.<sup>4</sup> 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.<sup>5</sup> Holding time is 7 days to extraction and extracts must be analyzed within 40 days from extraction.

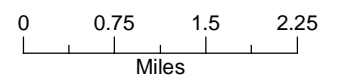




**Figure 1**  
**Lower Willamette Watershed**  
 Lower Willamette River

**LEGEND**

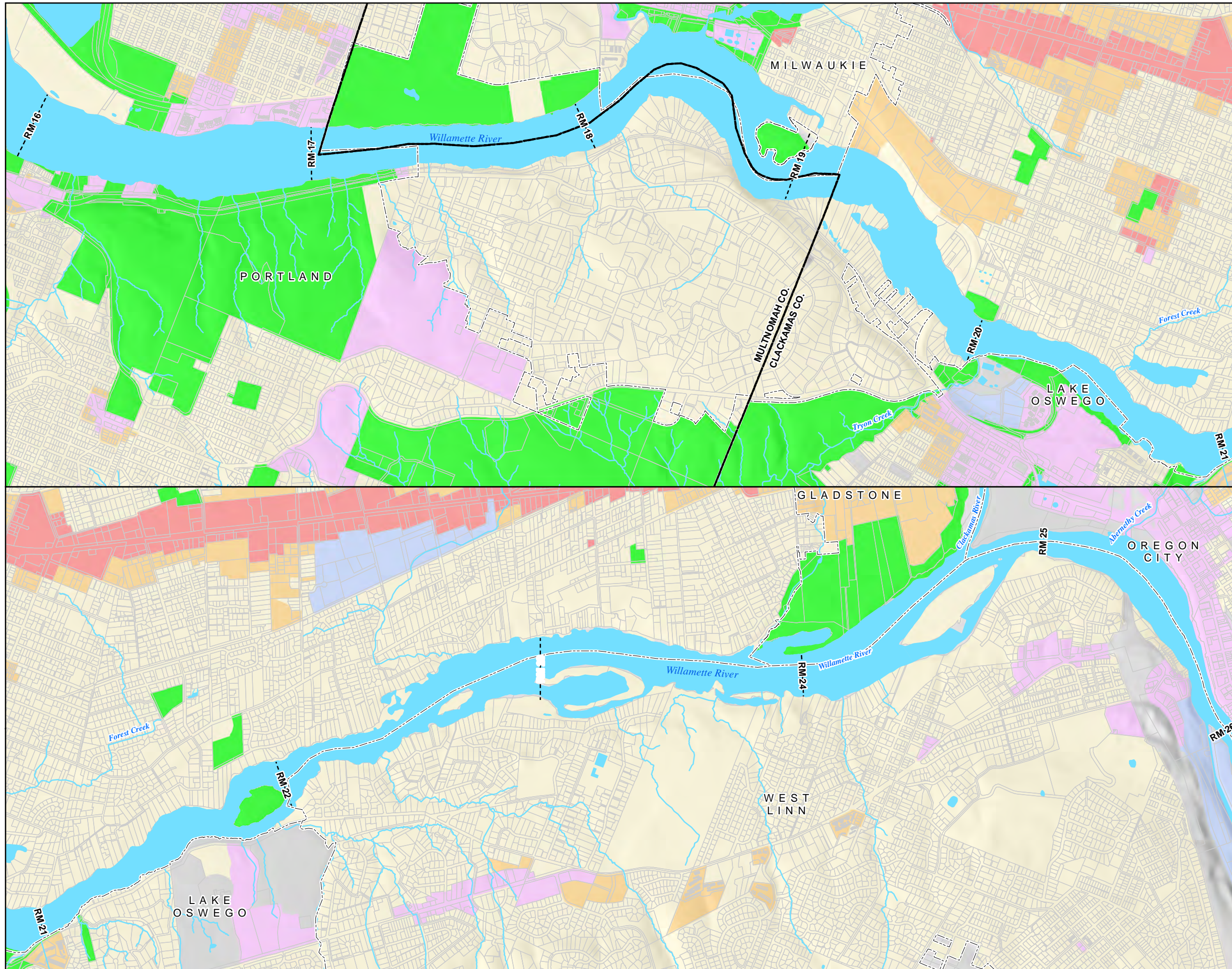
- Willamette Watershed Basin**
- 8 Digit Hydrologic Unit Code (HUC)
    - Clackamas
    - Lower Willamette
    - Middle Willamette
    - Tualatin
  - Sub-Basin Unit - 12 Digit HUC
- All Other Features**
- County Line
  - City Limit
  - River Mile (RM)
  - Watercourse
  - Waterbody



Date: August 25, 2017  
 Data Sources: BES, METRO, COP



**Figure 2**  
**Land Use in the Upriver Reach**  
**River Mile 16.6 to 26**  
**Lower Willamette River**



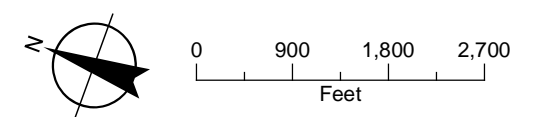
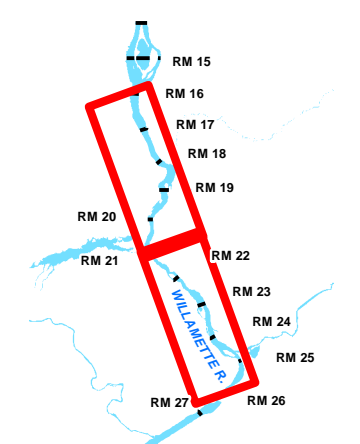
**LEGEND**

**Zoning**

- Commercial
- Industrial
- Multi Family Residential
- Mixed Use Residential
- Public Facilities
- Parks and Open Spaces
- Single Family

**All Other Features**

- Tax Lot
- City Limit
- County Line
- River Mile (RM)
- Watercourse
- Waterbody

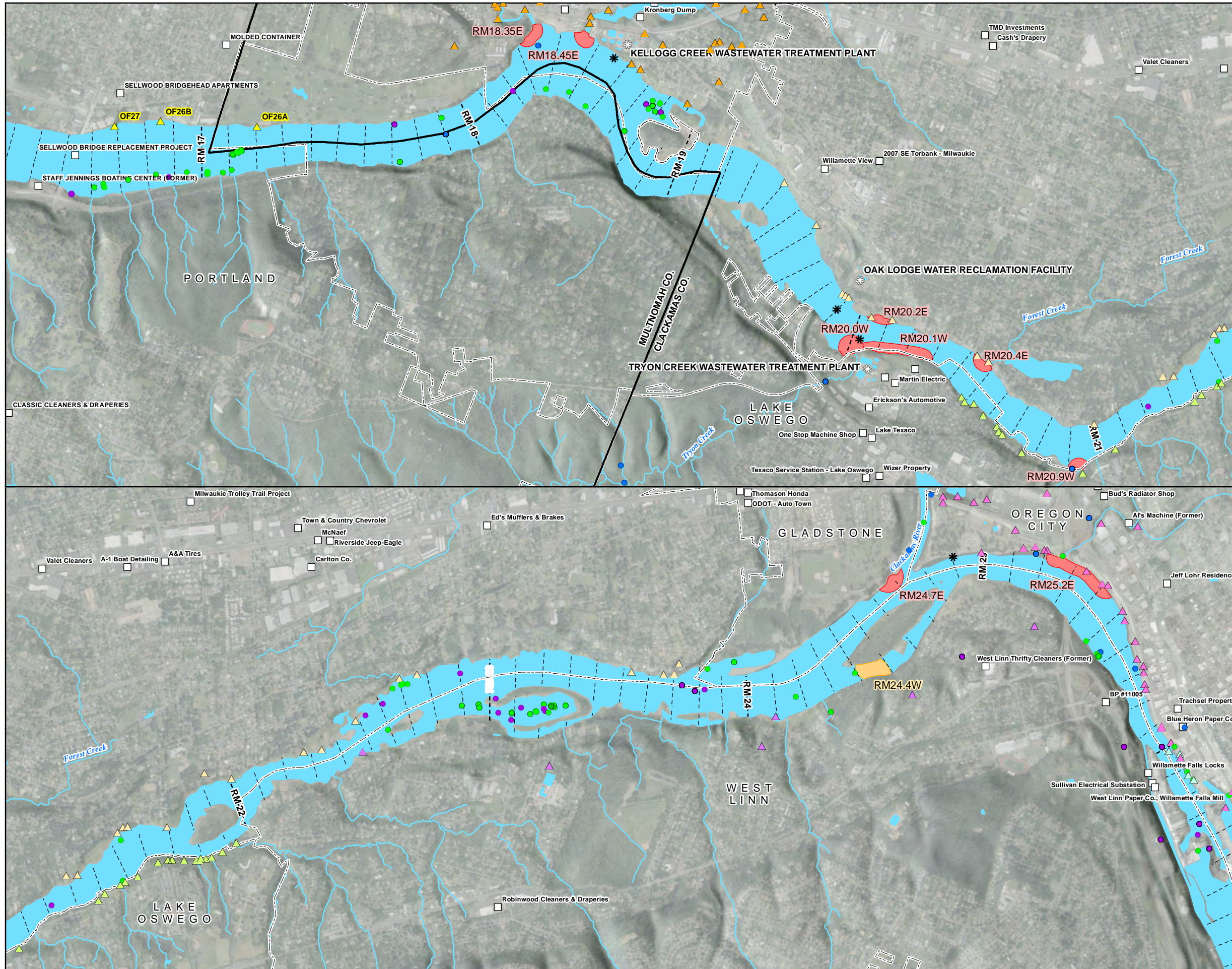


Date: August 25, 2017  
 Data Sources: BES, METRO, COP



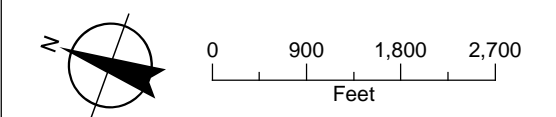
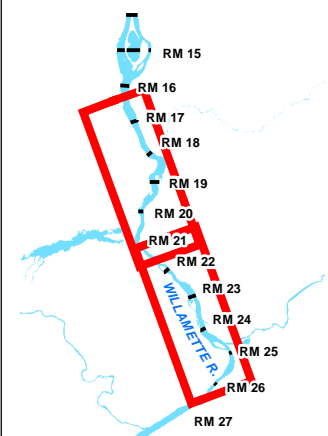


**Figure 3a**  
**Sediment Sampling Locations**  
 River Mile 16.6 to Willamette Falls  
 Lower Willamette River



**LEGEND**

- URSC Sample Area
- Optional URSC Sample Area
- Outfalls**
- Blue Heron Paper Mill Outfall
- City of Lake Oswego Outfall
- City of Milwaukie Outfall
- City of Portland Outfall
- City of West Linn Outfall
- Oak Lodge Water Services Outfall
- Oregon City Outfall
- Historical Sampling Location**
- Surface Sediment
- Water
- Biological
- All Other Features**
- River Mile (RM)
- DEQ ECSI Site
- Wastewater Treatment Plant
- Wastewater Treatment Plant Discharge Point (approximate)
- City Limit
- County Line
- Watercourse
- Waterbody

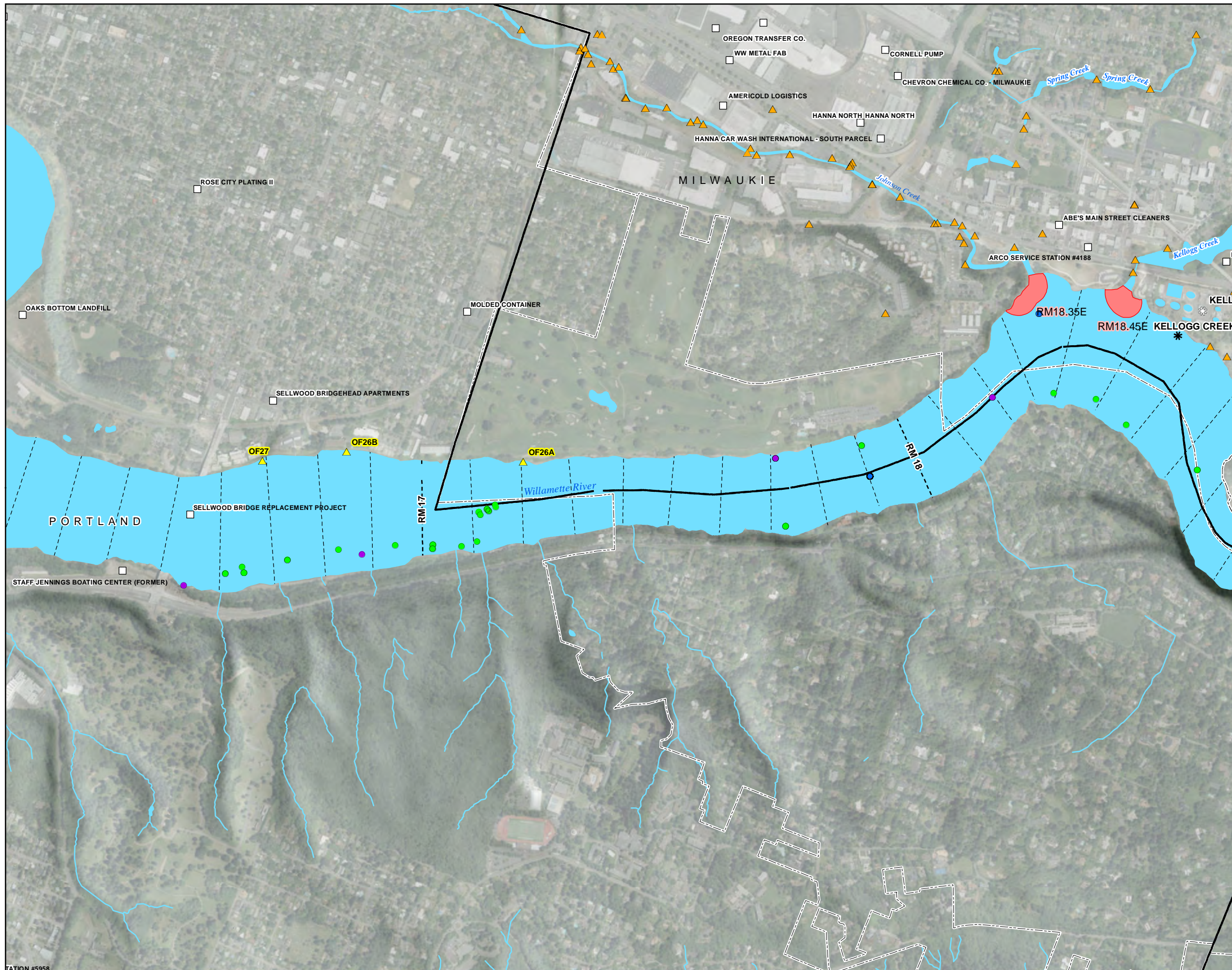


Note: Location information for outfalls beyond what is depicted was not readily available.  
 Date: November 16, 2017  
 Data Sources: BES, METRO, COP



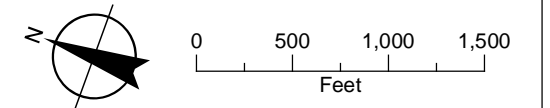
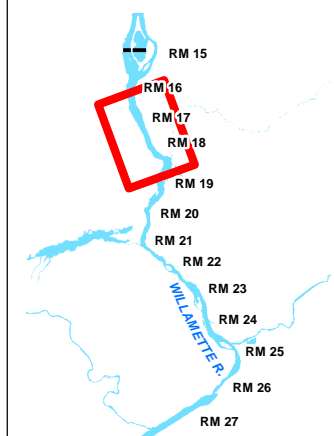


**Figure 3b**  
**Sediment Sampling Locations**  
 River Mile 16 to 18  
 Lower Willamette River



**LEGEND**

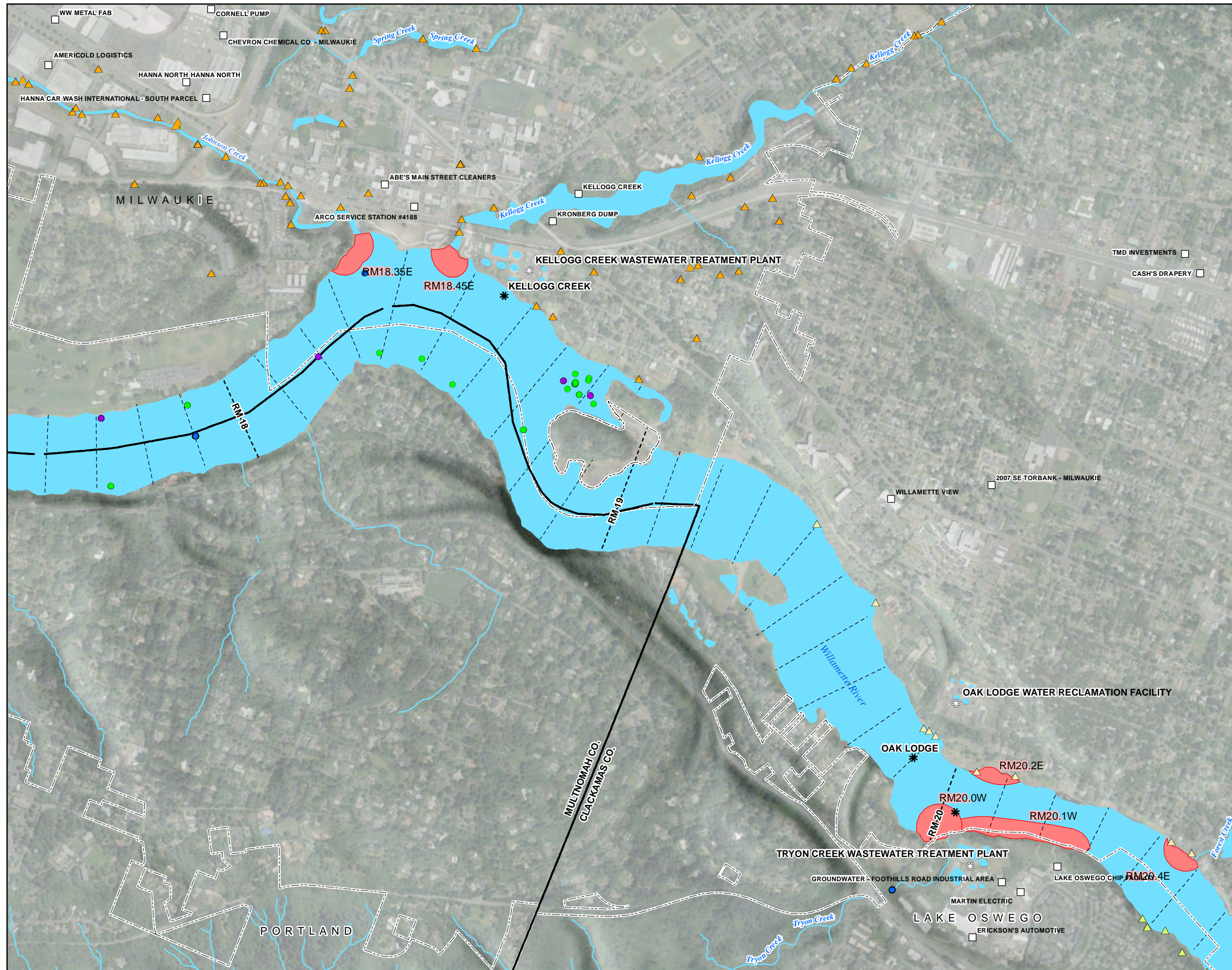
- URSC Sample
- Optional URSC Sample
- Historical Sampling Location**
- Surface Sediment
- Water
- Biological
- Outfalls**
- ▲ Blue Heron Paper Mill Outfall
- ▲ City of Lake Oswego Outfall
- ▲ City of Milwaukie Outfall
- ▲ City of Portland Outfall
- ▲ City of West Linn Outfall
- ▲ Oak Lodge Water Services Outfall
- ▲ Oregon City Outfall
- All Other Features**
- River Mile (RM)
- DEQ ECSI Site
- ☼ Wastewater Treatment Plant
- \* Wastewater Treatment Plant Discharge Point (approximate)
- City Limit
- ┌ County Line
- ~ Watercourse
- ~ Waterbody



Date: November 16, 2017  
 Data Sources: BES, METRO, COP

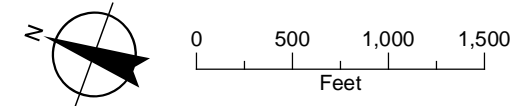
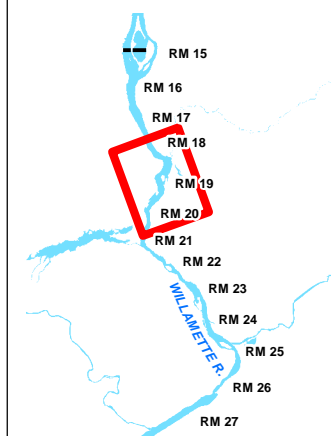


**Figure 3c**  
**Sediment Sampling Locations**  
 River Mile 18 to 20  
 Lower Willamette River



**LEGEND**

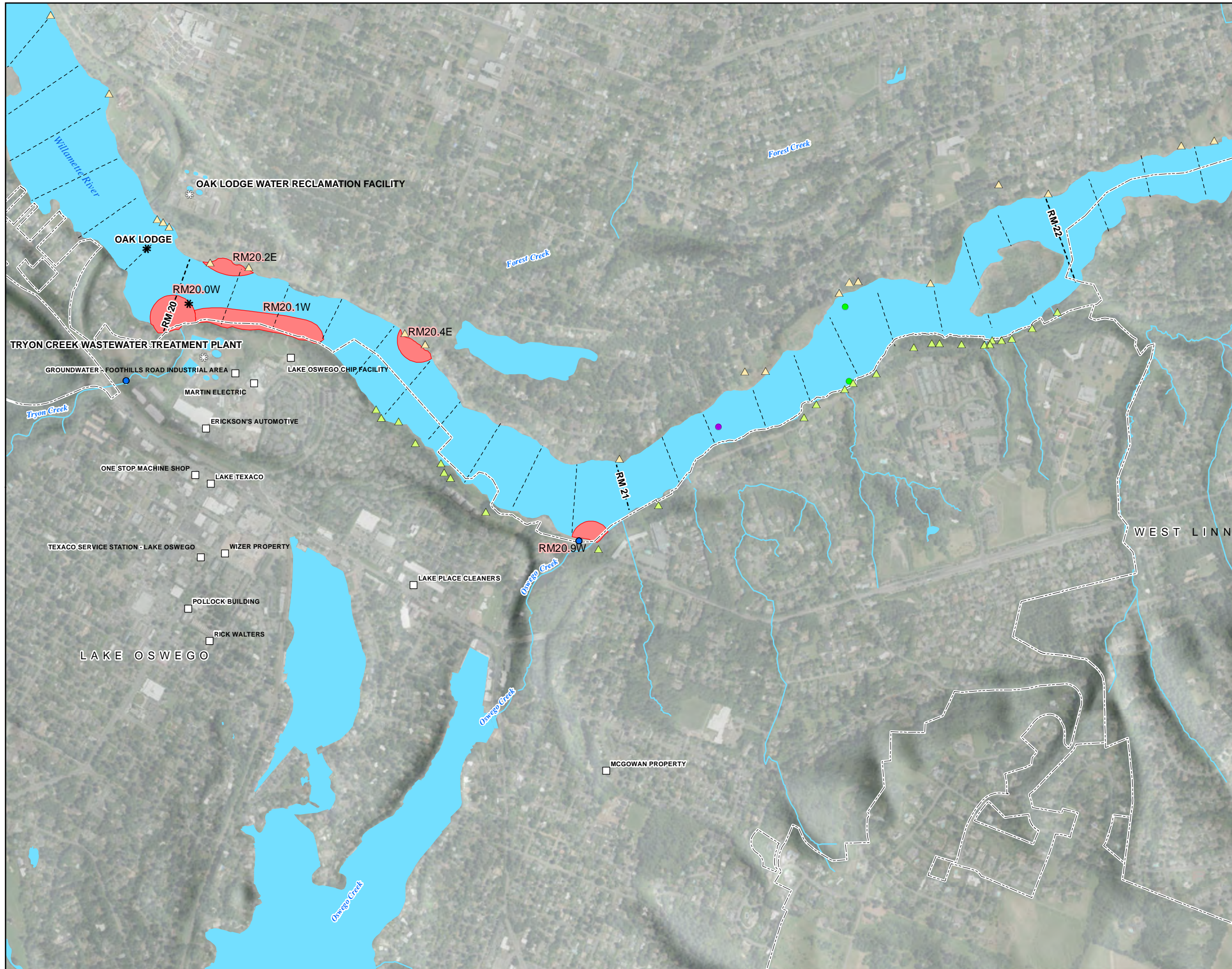
- URSC Sample
- Optional URSC Sample
- Historical Sampling Location**
- Surface Sediment
- Water
- Biological
- Outfalls**
- ▲ Blue Heron Paper Mill Outfall
- ▲ City of Lake Oswego Outfall
- ▲ City of Milwaukie Outfall
- ▲ City of Portland Outfall
- ▲ City of West Linn Outfall
- ▲ Oak Lodge Water Services Outfall
- ▲ Oregon City Outfall
- All Other Features**
- River Mile (RM)
- DEQ ECSI Site
- ☼ Wastewater Treatment Plant
- \* Wastewater Treatment Plant Discharge Point (approximate)
- City Limit
- ┌ County Line
- ~ Watercourse
- Waterbody



Date: November 16, 2017  
 Data Sources: BES, METRO, COP

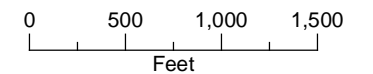
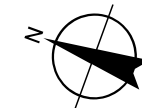
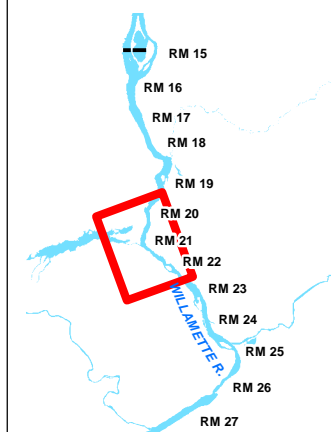


**Figure 3d**  
**Sediment Sampling Locations**  
**River Mile 20 to 22**  
**Lower Willamette River**



**LEGEND**

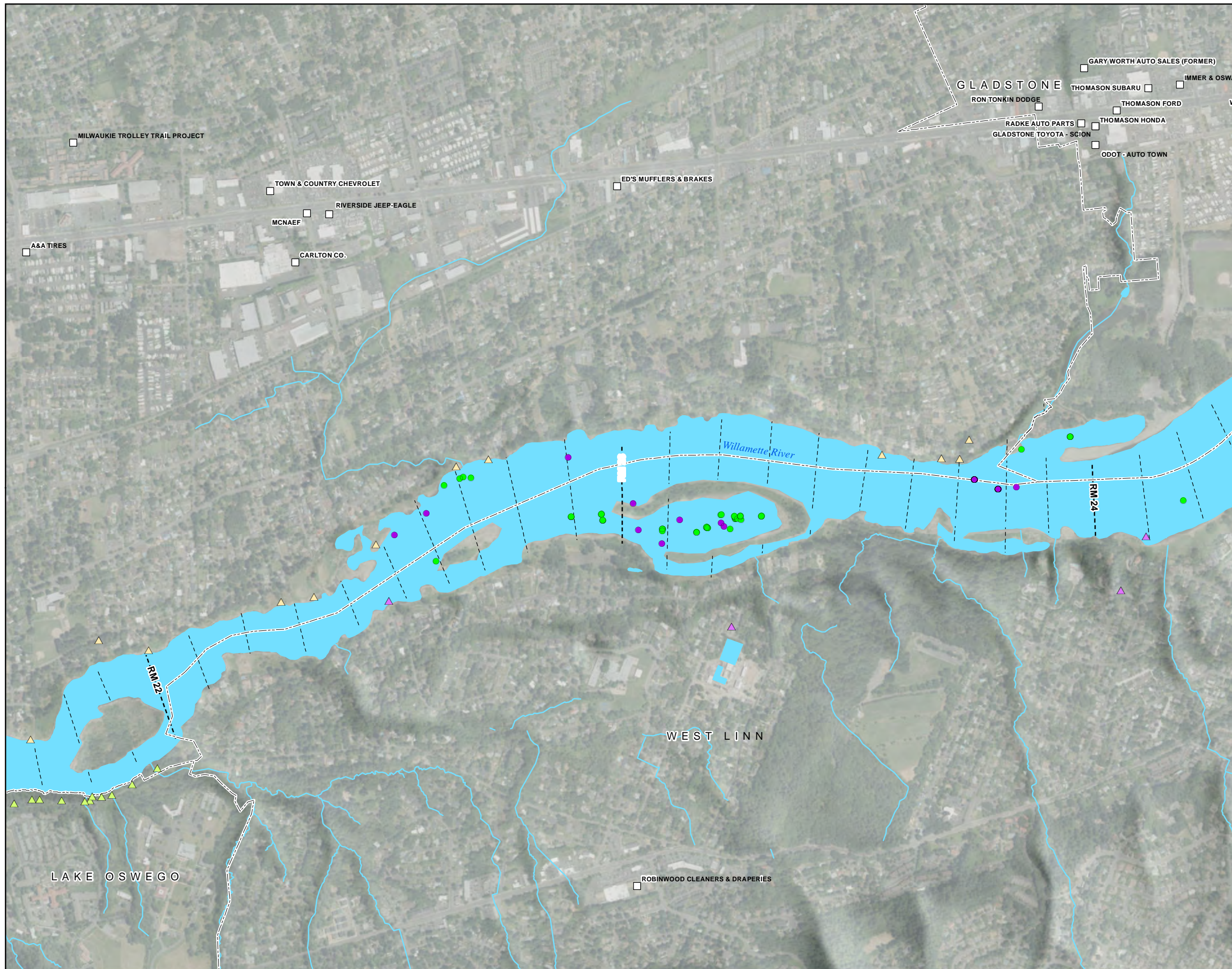
- URSC Sample
- Optional URSC Sample
- Historical Sampling Location**
- Surface Sediment
- Water
- Biological
- Outfalls**
- Blue Heron Paper Mill Outfall
- City of Lake Oswego Outfall
- City of Milwaukie Outfall
- City of Portland Outfall
- City of West Linn Outfall
- Oak Lodge Water Services Outfall
- Oregon City Outfall
- All Other Features**
- River Mile (RM)
- DEQ ECSI Site
- Wastewater Treatment Plant
- Wastewater Treatment Plant Discharge Point (approximate)
- City Limit
- County Line
- Watercourse
- Waterbody



Date: November 16, 2017  
 Data Sources: BES, METRO, COP

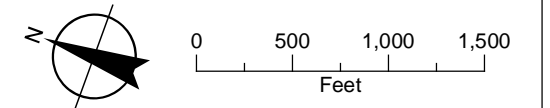
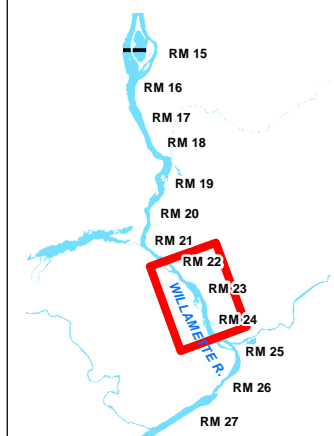


**Figure 3e**  
**Sediment Sampling Locations**  
**River Mile 22 to 24**  
**Lower Willamette River**



**LEGEND**

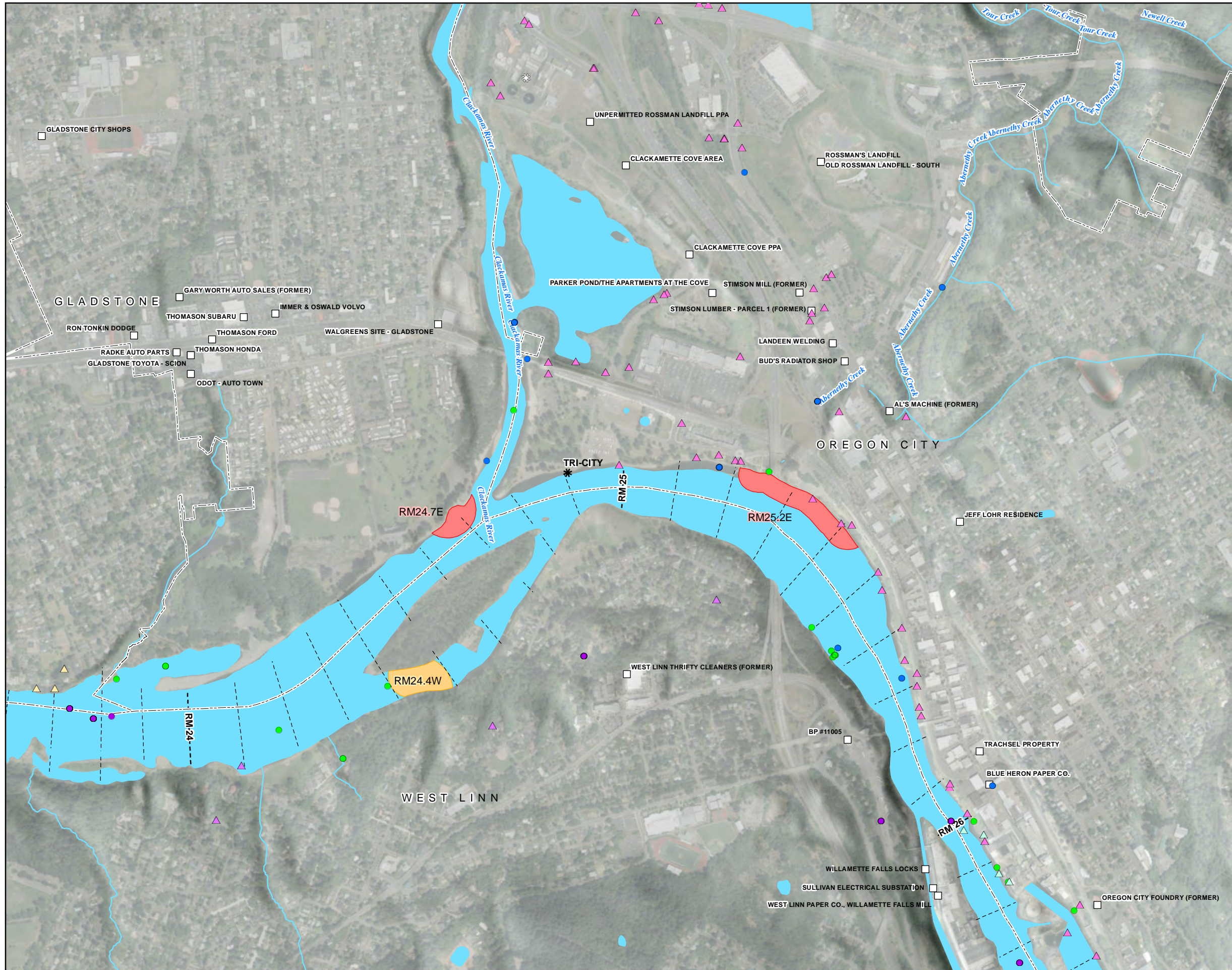
- URSC Sample
- Optional URSC Sample
- Historical Sampling Location**
- Surface Sediment
- Water
- Biological
- Outfalls**
- ▲ Blue Heron Paper Mill Outfall
- ▲ City of Lake Oswego Outfall
- ▲ City of Milwaukie Outfall
- ▲ City of Portland Outfall
- ▲ City of West Linn Outfall
- ▲ Oak Lodge Water Services Outfall
- ▲ Oregon City Outfall
- All Other Features**
- River Mile (RM)
- DEQ ECSI Site
- ☼ Wastewater Treatment Plant
- \* Wastewater Treatment Plant Discharge Point (approximate)
- City Limit
- └ County Line
- ~ Watercourse
- Waterbody



Date: November 16, 2017  
 Data Sources: BES, METRO, COP

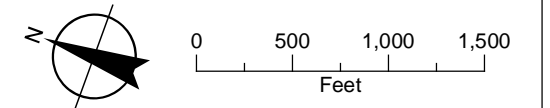
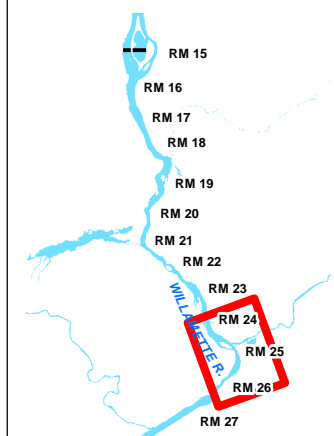


**Figure 3f**  
**Sediment Sampling Locations**  
 River Mile 24 to 26  
 Lower Willamette River



**LEGEND**

- URSC Sample
- Optional URSC Sample
- Historical Sampling Location**
- Surface Sediment
- Water
- Biological
- Outfalls**
- Blue Heron Paper Mill Outfall
- City of Lake Oswego Outfall
- City of Milwaukie Outfall
- City of Portland Outfall
- City of West Linn Outfall
- Oak Lodge Water Services Outfall
- Oregon City Outfall
- All Other Features**
- River Mile (RM)
- DEQ ECSI Site
- Wastewater Treatment Plant
- Wastewater Treatment Plant Discharge Point (approximate)
- City Limit
- County Line
- Watercourse
- Waterbody



Date: November 16, 2017  
 Data Sources: BES, METRO, COP