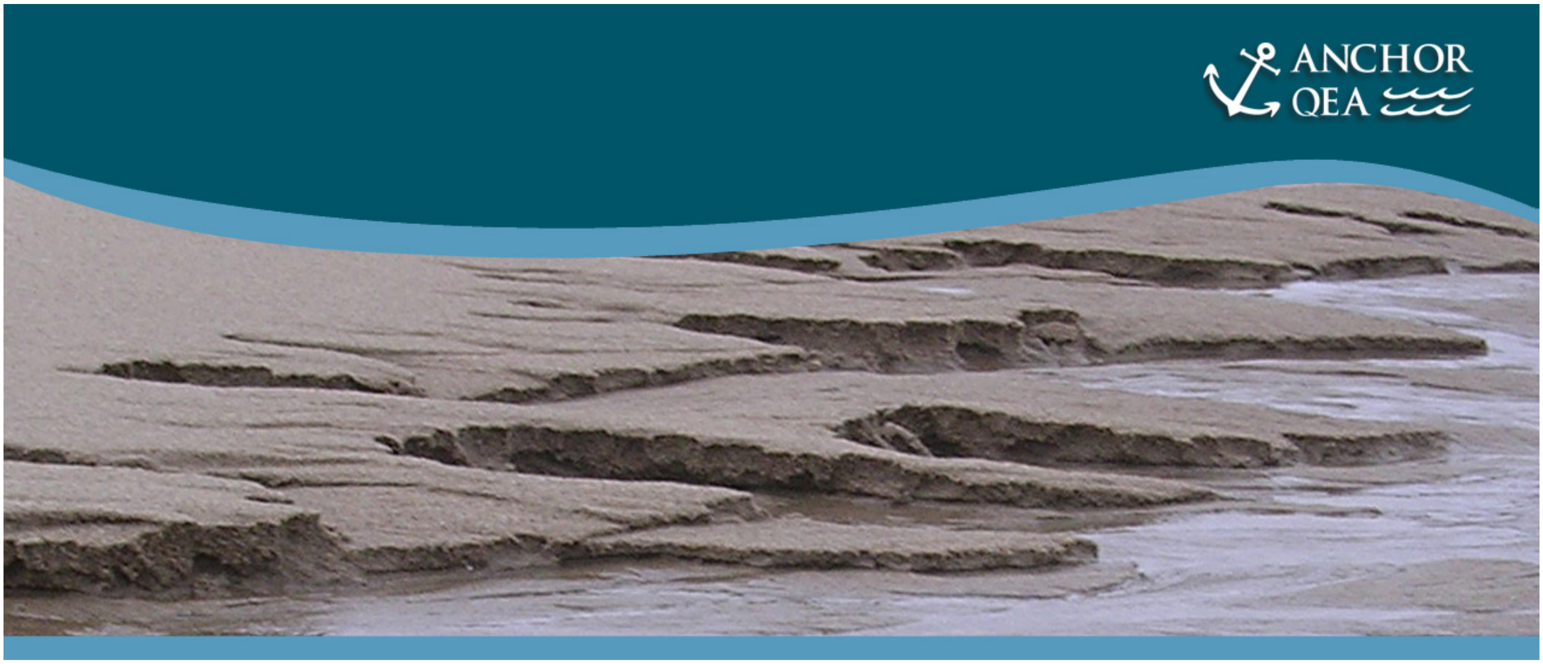

OPERATIONS, MONITORING, AND MAINTENANCE PLAN
MOUTH OF HYLEBOS WATERWAY (SEGMENTS 3, 4, AND 5)
TACOMA, WASHINGTON

Prepared for

Occidental Chemical Corporation
and
Port of Tacoma

Prepared by

Anchor QEA, LLC.
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Seattle, Washington 98101

December 2015

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LIST OF ACRONYMS AND ABBREVIATIONS

DMMP	Dredged Material Management Program
EIM	Environmental Information Management
EPA	U.S. Environmental Protection Agency
HCB	hexachlorobenzene
HCBD	hexachlorobutadiene
HCC	Hylebos Cleanup Committee
NCD	Nearshore Confined Disposal
Occidental	Occidental Chemical Corporation
OMMP	Operations, Maintenance, and Monitoring Plan
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
Port	Port of Tacoma
PRDE	Pre-Remedial Design Evaluation
RACR	Remedial Action Construction Report
RD	remedial design
ROD	Record of Decision
SMA	Sediment Management Area
SOW	Statement of Work
SQO	sediment quality objective
SRAL	sediment remedial action level
TOC	total organic carbon
TPU	Tacoma Public Utilities

1 INTRODUCTION

This document presents the Operations, Maintenance, and Monitoring Plan (OMMP) for sediment remedial actions including dredging, confined disposal, capping, and monitored natural recovery in the Mouth of Hylebos Waterway (Segments 3, 4, and 5) in Tacoma, Washington. A vicinity map of the project site is presented in Figure 1. In 2003 and 2004, sediments were dredged from the Mouth of Hylebos Waterway and were transported to either the Commencement Bay Dredged Material Management Program (DMMP) open-water disposal site, or the Slip 1 Nearshore Confined Disposal (NCD) Facility that was constructed adjacent to the Blair Waterway. Sediments were disposed of in a manner consistent with remedial design (RD) plans approved by the U.S. Environmental Protection Agency (EPA) (Hart Crowser et al. 2003), as described in the 2005 Consent Decree between EPA, the Occidental Chemical Corporation (Occidental), the Port of Tacoma (Port), and others. Consistent with Consent Decree requirements, final Remedial Action Construction Reports (RACRs) for the Mouth of Hylebos Waterway were submitted to EPA in June 2014 (Occidental and Port 2014a and 2014b).

This OMMP also addresses groundwater sampling at the Slip 1 NCD, located along the Blair Waterway at what is currently referred to as Port's Husky Terminal (also referred to as Pier 3 or Terminal 3/4). The Groundwater Sampling Operations Manual for that work is presented in Appendix A. Habitat mitigation monitoring activities associated with the Slip 1 NCD are presented in the separate Slip 5 Mitigation Site OMMP.

1.1 Purpose and Scope of the OMMP

This document describes the post-remedial action environmental monitoring activities that will be performed as part of the Mouth of Hylebos Waterway Cleanup Project. Appendices to this OMMP describe the specific field methodologies and other quality assurance/quality control measures for implementation of sediment quality and groundwater monitoring under this plan. A separate OMMP will be prepared for the Port Piers 24 and 25 environmental cap area and Occidental embankment area; accordingly, those areas are not addressed herein.

The overall objective of the monitoring programs described in this OMMP is to confirm that remedial actions performed at the site achieve performance standards specified in the

Commencement Bay Nearshore/Tideflats Record of Decision (ROD; EPA 1989) and the Hylebos Cleanup/Slip 1 NCD Facility Project Statement of Work (Hylebos Waterway Cleanup Project SOW [Statement of Work], Appendix A of the 2005 Consent Decree). Summarized below are the objectives of this OMMP that pertain to the elements specified in the 2005 Consent Decree/SOW:

1. The primary objective of the sediment monitoring described in this OMMP is to verify that surface sediment concentrations in post-dredging residual areas and other natural recovery areas within Segments 3 to 5 achieve sediment quality objectives (SQOs) within the time frame established by EPA in the ROD and SOW
2. The secondary objective of the sediment monitoring described in this OMMP is to evaluate the overall effectiveness of ongoing source control actions as measured by sediment quality over time and to support comparisons with surface sediment verification data collected separately in Segments 1 and 2 that appear to show a recent increasing trend in polychlorinated biphenyl (PCB) concentrations (DOF and D.M.D. Inc. 2012)
3. The objective of long-term monitoring of groundwater quality in the vicinity of the Slip 1 NCD Facility described in this OMMP is to demonstrate protection of surface water

The Consent Decree/SOW elements not included in this OMMP are presented in the OMMP for the Port Piers 24 and 25 Embankment Remediation Project and the Sediment Management Area (SMA) 421B Compensatory Mitigation Plan, which have been submitted separately to EPA.

This OMMP describes the following elements of post-remedial action monitoring activities:

- Data objectives, including rationale for the type, number, location, and frequency of samples to be collected
- Analyses to be performed
- Sampling equipment and methods to be used
- Reporting requirements

This OMMP also identifies points of compliance for the remedial action and potential contingency response actions that might be implemented in the event that the remedial actions do not meet their respective performance standards.

1.2 Project Management

This section provides an overview of project management activities, outlining roles and responsibilities, data management, and deliverable requirements.

1.2.1 Roles and Responsibilities

Since 1993, Occidental and the Port have been working closely and cooperatively with the EPA and the other oversight agencies to complete cleanup of the Mouth of Hylebos Waterway. As summarized in the RACRs (Occidental and Port 2014a and 2014b), remedial action work plans previously approved by EPA described the overall project management strategy and implementation plan to accomplish required remedial actions within the Mouth of Hylebos Waterway, which were completed in 2005.

An organization chart for OMMP implementation is provided in Figure 2. EPA is the regulatory authority and responsible agency for overseeing and authorizing the OMMP described herein. The EPA Project Coordinator, or his designee, will exercise project oversight for the agency and coordinate with Occidental and the Port.

The project will be managed by Occidental and the Port and be executed by consultants specializing in sediment and groundwater work. Clint Babcock with Glenn Springs Holdings, an affiliate of Occidental, and Rob Healy with the Port, or their future designees, will be the primary contacts for EPA communications and required EPA reporting, including progress reports, schedule updates, and other project management tasks. Occidental and the Port are responsible for implementation of the OMMP including monitoring of the consultant's quality control activities to ensure work is conducted in accordance with this OMMP.

1.2.2 Data Management

Data collected for this project will be validated and submitted to EPA in a format suitable for upload into EPA's Environmental Information Management (EIM) database.

1.2.3 Deliverables

A Data Report will accompany the EIM data submittal. The Data Report will contain a synopsis of any deviations from work plans, along with data validation reports and interpretive summaries as described in this OMMP. New data will be tabulated and provided in written form and an electronic format capable of being transferred into EPA's EIM data management system. The requirement for electronic submittal will be complete when EPA confirms all data are properly submitted into the EIM.

1.3 Organization of the OMMP

Following this introductory section, Section 2 of the OMMP presents sediment quality monitoring focusing on natural recovery areas, overlapping sediment stability and protectiveness monitoring, and source control monitoring. Section 3 presents monitoring plans for groundwater quality. Attachments to this OMMP present detailed plans related to field sampling procedures and other quality assurance requirements.

2 SEDIMENT QUALITY MONITORING

This section presents plans for long-term monitoring and confirmation of sediment natural recovery and discusses overlapping sediment stability and protectiveness monitoring and source control monitoring. All sediment samples will be analyzed for the full suite of Mouth of Hylebos contaminants of concern. For consistency, the disparate historical sediment location nomenclature have been replaced with the study purpose prefix (OMMP) and numeric identifier (1 through 40). For example, historical station HY-321-1 has been revised to station OMMP-36. The new and historical station identification are listed in Table 1. The sediment sampling locations are shown in Figure 3.

2.1 Natural Recovery Sediment Quality Monitoring

The surface sediment quality of natural recovery areas will be monitored to verify the effectiveness of natural recovery in reducing concentrations of chemicals of concern over time. Surface sediment chemistry data from natural recovery areas will be compared with SQO criteria.

2.1.1 Location-Specific Sediment Remedial Action Levels

As defined in the ROD and Hylebos Waterway Cleanup Project SOW, the sediment remedial action level (SRAL) for a given chemical is the sediment concentration predicted to decrease to the SQO within a 10-year natural recovery period. Numerical SRALs vary by location within the Hylebos Waterway, largely because of varying sedimentation rates. SRALs for the project area were developed in the Hylebos Waterway Pre-Remedial Design Evaluation (PRDE) report approved by EPA (HCC 1999), and represent conservative estimates of the natural recovery potential at different locations within the waterway. The point of compliance for achieving SQOs is defined in the ROD as the top 10 centimeters of sediment.

2.1.2 Surface Sediment Natural Recovery Monitoring

Surface sediments will be sampled within designated natural recovery areas to confirm predictions of natural recovery over the next 10 years. As defined in the SOW, the 10-year natural recovery timeframe will begin upon EPA's approval of the RACRs (Occidental and Port 2014a and 2014b). Certification of completion of the RACRs is currently pending.

Natural recovery monitoring within the Mouth of Hylebos Waterway will be performed at sampling locations that exceeded SQO chemical criteria during the most recent sampling, but were nevertheless below the location-specific SRAL performance standard. Natural recovery monitoring will be performed in Segments 3 to 5, within designated natural recovery areas (Hart Crowser et al. 2003):

- **Chinook Marina** (represented by Stations OMMP-8, OMMP-9, OMMP-11, OMMP-13, OMMP-14, and OMMP-15), which exceeded SQO chemical criteria for cadmium, copper, hexachlorobenzene (HCB), and/or hexachlorobutadiene (HCBD) during RD
- **Navy Bank Nearshore** (represented by Stations OMMP-19 and OMMP-20), which exceeded SQO chemical criteria for polynuclear aromatic hydrocarbons (PAHs) and/or dichlorodiphenyl-trichloroethane (DDT) breakdown products during RD
- **Tacoma Public Utilities** (TPU) Nearshore (Station OMMP-24), which exceeded SQO chemical criteria for PAHs and PCBs during RD
- **Simons Nearshore** (SMA 401; represented by Station OMMP-31), which exceeded SQO chemical criteria for PCBs and phthalates during RD
- **Buffelen Embankment** (SMA 341; represented by Station OMMP-34), exceeded SQO chemical criteria for PAHs and PCBs during RD
- **Murray-Pacific Channel** (represented by Station OMMP-37), in the vicinity of an existing sanitary sewer line, which exceeded SQO chemical criteria for PCBs during RD
- **Wasser Winters Nearshore** (SMA 103; represented by Station OMMP-40) in Segment 1, which exceeded SQO chemical criteria for DDT breakdown products during RD; this area is also of potential concern with respect to possible metals, PAHs, and PCB releases

Natural recovery monitoring sampling also will be conducted in Segments 3 to 5 dredging areas where post-dredge residual sediment concentrations exceeded one or more SQO chemical criteria at the completion of remedial dredging, but were nevertheless below the location-specific SRAL dredging performance standards. To verify anticipated recovery to SQO chemical criteria, confirmatory post-dredge natural recovery monitoring will be performed in these areas:

- **Segment 5 Channel**, re-occupying those post-dredge verification sampling stations that had residual concentrations exceeding SQO chemical criteria for HCBD

(Stations OMMP-3 through OMMP-7, OMMP-10, OMMP-12, OMMP-16 through OMMP-18, and OMMP-21); Station OMMP-22, located near the boundary between Segments 4 and 5, exceeded SQO chemical criteria for PCBs

- **American Nearshore** (SMA 421B), re-occupying those post-dredge verification sampling stations that had residual concentrations exceeding SQO chemical criteria for one or more PAHs (Stations OMMP-26 through OMMP-28)
- **Sound Refining Shoaling Area** (SMA S44), re-occupying those post dredge verification stations where PCBs and/or arsenic concentrations were greater than the SQO (Stations OMMP-33 and OMMP-35)

These natural recovery monitoring locations are depicted in Figure 3, including one or more natural recovery monitoring stations within each of the natural recovery areas listed above. Co-location of sampling locations, with PRDE and/or post-dredge verification stations as appropriate, will allow an accurate assessment of natural recovery over time.

The natural recovery monitoring will include analyses, as summarized in Table 1.

Sample collection procedures are described in Appendix B, Attachment 1. Sediment natural recovery monitoring is targeted to begin in late 2015. Follow-on sediment monitoring is described in Section 2.4.

2.2 Sediment Stability and Protectiveness Monitoring

In addition to surface sediment natural recovery monitoring as described in Section 2.1.2, the SOW also requires confirmation of the continued containment and protectiveness of subsurface contaminated sediment deposits. As discussed in the final design documents and RACRs (Occidental and Port 2014a and 2014b), subsurface contaminated sediment deposits overlain with surface sediments below SQO chemical criteria are located in portions of Segments 3 and 4. This OMMP includes sediment stability and sampling to ensure the continued protectiveness of these areas, as described further in this section.

For navigational purposes, the Port and the U.S. Army Corps of Engineers complete bathymetry surveys of Port Waterways, including the Hylebos Waterway every 2 years.

While the original 2006 post-construction bathymetric surveys summarized in the RACRs (Occidental and Port 2014a and 2014b) were performed on transects, the newer Port data are available in Raster format, providing more accurate data comparisons. The more recent Port bathymetry surveys performed in 2011 and 2015 are compared in Figure 3, revealing stable sediments over that period. Available bathymetric data will continue to be evaluated during the OMMP to assess potential deposition, scour, and dynamic equilibrium in subsurface contamination areas.

Subsurface sediment protectiveness monitoring will include surface sediment sampling in subsurface contaminated sediment deposit areas of Segment 4 and Segment 3 as follows:

- **TPU** (SMA 402; Station OMMP-24)
- **Simons Channel** (SMA 401A; Stations OMMP-29, OMMP-30, and OMMP-32)
- **Murray-Pacific Channel** (SMA 322 and adjacent areas; Stations OMMP-36, OMMP-38, and OMMP-39)

The sediment stability and protectiveness monitoring will include analyses as summarized in Table 1.

2.3 Source Control Monitoring

As discussed in Section 1.1 and consistent with the SOW, a secondary objective of this OMMP is to evaluate the overall effectiveness of source control actions in the Hylebos Waterway as measured by sediment quality over time and to support comparisons with surface sediment verification data collected separately in Segments 1 and 2 that appear to show a recent increasing trend in PCB concentrations (DOF and D.M.D. Inc. 2012). Surface sediment samples collected from the following twelve representative stations have been selected for this purpose:

- OMMP-1
- OMMP-2
- OMMP-3
- OMMP-10
- OMMP-22
- OMMP-23

- OMMP-25
- OMMP-33
- OMMP-35
- OMMP-36
- OMMP-38
- OMMP-39

When combined with other coordinated long-term monitoring programs, the aggregate long-term monitoring data are anticipated to be sufficient to evaluate the overall effectiveness of source control actions in the Hylebos Waterway.

2.4 Future Sediment Quality Monitoring and Potential Corrective Actions

The scope of further sediment monitoring will be determined based on the results of the 2015 sampling, detailed in Sections 2.1 through 2.3 above. The sampling stations identified in this OMMP may or may not become part of future OMMP sediment sampling events, depending on initial analytical results, evaluation of overall waterway recontamination issues, and future discussions with EPA and other stakeholders. Appropriate future sampling frequencies will also be determined based on this review and may also consider multi-increment sampling, modifications to constituents and analytical methods, and sampling methods if warranted.

In the event that SQO chemical criteria are exceeded in surface samples collected under this OMMP, sediment bioassay testing may be employed to confirm or refute an SQO exceedance, consistent with the ROD. In the event that SRALs are exceeded, the need for enhanced natural recovery or active sediment remediation will be reassessed with EPA, consistent with the 2000 Explanation of Significant Differences. If future sediment quality conditions suggest significant ongoing contaminant sources to the Hylebos Waterway, the potential for additional source control measures will be discussed between the Port, Occidental, EPA, and other stakeholders, as source control was not an anticipated element of the Consent Decree/SOW.

3 GROUNDWATER QUALITY MONITORING

This section describes the groundwater quality monitoring program for the Slip 1 NCD Facility.

3.1 Groundwater Monitoring Objectives and Performance Standard

The objective of this monitoring program is to protect water quality in adjacent surface water (Blair Waterway and Commencement Bay) from contaminants that could potentially migrate in groundwater from the Slip 1 NCD Facility. The groundwater monitoring performance standard for this project is achievement of marine chronic criteria or ambient concentrations (whichever are numerically higher) in adjacent surface water. The point of compliance for this performance standard is the sediment and surface water interface outside of the berm and peninsulas surrounding the NCD Facility. The site groundwater monitoring wells do not represent the point of compliance; they are generally located upgradient of it. Therefore, an exceedance of applicable surface water criteria in a site monitoring well does not demonstrate that the performance standard is not being achieved. Rather, it would represent a trigger for additional assessment or action, as described below. However, monitoring water quality within the base of the biologically active zone of sediment, where groundwater discharge is highly episodic due to tides, is difficult. Monitoring wells provide easy-to-obtain water quality data that can be used to assess compliance with performance standards.

The monitoring program is designed to detect and evaluate possible long term changes in groundwater quality in the areas surrounding the NCD Facility to ensure compliance with the performance standards. The program includes the collection, analysis, and interpretation of hydrogeologic and groundwater quality data from existing and proposed monitoring wells installed within and around the perimeter of the Slip 1 NCD Facility (Figure 4). Groundwater quality data will be collected and analyzed from existing and proposed wells installed around the perimeter of the Slip 1 NCD Facility.

Specific objectives of the groundwater monitoring program are to:

- Document the post-construction groundwater flow regime for the Slip 1 NCD Facility, including groundwater travel times
- Establish baseline groundwater quality around the NCD Facility

- Monitor groundwater quality over time, using statistical techniques to identify significant departures from baseline conditions
- Evaluate the potential for impact to the adjacent surface water by implementing appropriate response actions if significant changes in groundwater quality are detected during monitoring

This section of the OMMP defines the approach for (1) documenting post-construction groundwater flow conditions and baseline groundwater quality; and (2) using that information, establishing the appropriate groundwater quality compliance monitoring program for the Slip 1 NCD Facility. The field sampling and quality assurance protocols, as well as health and safety considerations, are presented in Appendix A, Groundwater Sampling Operations Manual.

3.2 Groundwater Monitoring Approach

The groundwater quality monitoring approach is designed to evaluate protection of the adjacent surface water bodies. Initially, baseline groundwater quality will be established for those monitoring wells determined to be appropriate, based on post-construction groundwater flow conditions. Once baseline has been established, compliance monitoring will commence. The compliance monitoring program is designed to determine whether concentrations of selected constituents demonstrate a statistically significant increase, relative to baseline groundwater quality, as a result of construction of the Slip 1 NCD Facility. Actions that will be accomplished include routine monitoring of groundwater quality and statistical analysis of the results, consistent with current EPA guidance and professional practice. If statistically significant concentration increases are observed in groundwater, the Port and Occidental will propose to EPA whether to initiate one or more response actions appropriate to the nature of the increase.

As part of this monitoring program, the Port, Occidental, and EPA will periodically review the utility of the various monitoring elements. If any of the elements are no longer necessary, the Port, Occidental, and EPA may agree to terminate any or all of the monitoring elements. Conversely, if additional elements are warranted, such as new monitoring wells, they may be added as necessary upon agreement by the Port, Occidental, and EPA.

3.3 Hydrogeologic Conditions

Upon filling, the Slip 1 NCD Facility became part of the adjacent upland area with a groundwater flow system similar to that observed beneath other Commencement Bay land masses bordered by waterways. This section briefly summarizes the subsurface physical conditions pertinent to the design and operation of the groundwater quality monitoring program.

Subsurface deposits in the areas surrounding Slip 1 consist predominantly of silty sand with silt layers of variable lateral and vertical extent. Because the grain size of the fill material placed in Slip 1 was consistent with the adjacent soil types, these deposits likely collectively form a single unconfined water-bearing system with the existing materials on both sides of the fill.

Prior to filling, groundwater discharged locally from three sides into Slip 1. With the fill in place, the groundwater flow system is anticipated to establish a new equilibrium, with groundwater likely flowing generally northward along the approximate axis of the fill. Numerical groundwater modeling has been completed to predict the post-construction groundwater flow system within and around the Slip 1 NCD Facility (CRA 2000a). Based on this modeling, the predicted net groundwater flow direction in the vicinity of the Slip 1 NCD Facility is from the south to north, through the NCD Facility, with discharge to the Blair Waterway and Slip 5. While the net hydraulic gradient is predicted to be toward the Blair Waterway, short term reversals (with groundwater flow from the waterway toward the NCD Facility) will occur within and near the berm during high tides.

Based on this predictive groundwater flow modeling, the shortest time for groundwater to travel from the northern edge of the fill to the adjacent surface water (i.e., from the edge of the fill adjacent to the berm, through the containment berm, and into the Blair Waterway) would be on the order of 1 year (CRA 2000a). Groundwater travel times from the portions of the fill further away from the berm, such as the previously placed Area 5106 sediments, are expected to be considerably longer, taking possibly as much as 70 years or more.

3.4 Groundwater Monitoring Network

The proposed groundwater monitoring network consists of three existing wells and one new well at a location along the perimeter of Slip 1, three new shallow and three new deep wells in the containment berm, and one new well/piezometer in the fill (Figure 4). The well/piezometer within the fill is for the purpose of collecting hydraulic gradient information only. Collectively, this well network will provide groundwater elevation and quality data representative of horizontal groundwater flow anticipated from the fill material toward the Blair Waterway and Slip 5.

Existing monitoring wells to be used in the monitoring network include MW-1S 00, MW2S-00, and HCC-1. Well HCC-1 was installed in November 1995 (HCC 1996), to provide site-specific groundwater samples for use in sediment leaching tests. Wells MW1S-00 and MW2S-00 were installed near the mouth of Slip 1 in February 2000 (CRA 2000b), for use both in support of predictive contaminant transport modeling and for long-term monitoring as part of this OMMP. Existing monitoring wells MW3D-00 and MW4S-00 (CRA 2000b) are not included in the long-term groundwater quality monitoring network but may be used for groundwater elevation measurements. Based on predicted post-construction groundwater flow directions, well HCC-1 is anticipated to serve as an upgradient monitoring well.

Prior to installation of new wells, a condition survey of the existing monitoring wells will be performed. Well locations will be surveyed, the condition of the surface seal will be assessed, the amount of silt in the wells will be measured, and depth to water will be measured. Following the condition survey, a Work Plan will be prepared describing the installation and development of monitoring wells, the tidal study, and the slug test protocol.

Five new shallow wells (MW5S, MW6S, MW7S, MW8S, and MW9S) and three new deep wells (MW6D, MW8D, and MW9D) will be installed around and within the Facility (Figure 4) using the same procedures used to install wells MW1S-00 and MW2S-00 (CRA 2000b). New monitoring well MW5S will be installed along the southwest edge of the NCD Facility. The new monitoring wells located in the berm (MW6S, MW6D, MW8S, MW8D, MW9S, and MW9D) and the well/piezometer within the fill (MW7S) will be installed in conjunction with MW5S. The fill well/piezometer MW7S will be measured only to provide additional data on hydraulic conditions within the fill and will not be used to evaluate groundwater quality performance, except in the event that concentrations in the other monitoring wells begin to approach performance standards. The new shallow wells will be constructed with 10-foot screens set approximately from elevation 5 to -5 feet mean lower low water (MLLW), consistent with the existing wells HCC-1, MW1S-00, and MW2S-00. The monitoring wells will be screened to ensure that low tide sampling conditions are accommodated. The new deep wells will be constructed with 10-foot screens set approximately from elevation -28 to -38 feet MLLW. The monitoring wells will be screened within the fill and above the elevation of bottom of the slip. The new and existing wells will be developed prior to sampling.

This well network is designed to monitor the assumed "worst-case" groundwater quality around the Slip 1 NCD Facility. It is expected that the highest potential for mobilization of contaminants within the fill will occur with progressive flushing of the fill with less saline, more oxygen-rich groundwater (salt washout effect; Brannon et al. 1994). Shallow groundwater will be the freshest, most oxygen-rich groundwater entering and leaving the fill. The shallow well screens installed for the Slip 1 monitoring well network are positioned to cover a 10-foot vertical range representative of "shallow" groundwater conditions, thus providing a conservative representation of groundwater quality around the NCD Facility. Figure 5 is a cross section oriented west to east across the NCD Facility, depicting the screened intervals of existing wells MW1S-00 and MW2S 00 and the proposed fill well MW7S relative to the NCD Facility.

3.5 Documentation of Post-Construction Hydrogeologic Conditions

After installation of the well network, the new and existing groundwater monitoring network wells that will be sampled and/or measured will be surveyed, and the post-construction horizontal groundwater flow regime evaluated by completing two 72-hour tidal studies, one during the late summer and one during winter. The data collection will include continuous (every 15 minutes) transducer-based water level measurements in wells MW1S-00, MW2S-00, MW4S-00, MW5S, MW6S, MW6D, MW7S, MW8S, MW8D, MW9S, MW9D, and HCC-1. In addition, slug tests of all site monitoring wells will be performed to estimate aquifer hydraulic conductivity.

Net (tidally averaged) groundwater flow directions determined from the tidal study will provide the basis for determining the appropriate wells to include in the groundwater quality monitoring program. The groundwater data will be used to estimate groundwater flow velocities and travel times from the fill, which will be used to determine the appropriate frequency for long-term groundwater quality monitoring.

The post-construction hydrogeologic conditions will be documented in a report, which will be one of the documents used to establish the appropriate groundwater quality compliance monitoring program. This report will present the geologic and tidal study data collected, and integrate those data into a hydrogeologic conceptual model for the Slip 1 NCD Facility. The conceptual model will incorporate the post-construction stratigraphy (e.g., as-built cross sections through the NCD Facility), groundwater flow directions and velocities, and estimated times for groundwater to travel from the fill to reach wells around the NCD Facility and the adjacent surface water.

3.6 Baseline Groundwater Quality

Because groundwater quality can vary by both location and time, comparisons of long-term water quality data against baseline conditions will need to be made on an intra-well basis. As discussed above, the appropriate wells to include in the groundwater quality monitoring program (both baseline and subsequent compliance monitoring) will be determined based on the observed post-construction groundwater flow directions. The baseline monitoring program will include, at a minimum, wells MW6S, MW6D, and two of the NCD Facility perimeter wells.

To establish baseline groundwater quality in the selected monitoring wells, and evaluate whether seasonal trends are apparent, the baseline monitoring will consist of quarterly groundwater sampling and analysis for 1 year, with a total of four events. Groundwater velocities are expected to be slow enough that groundwater moving from the fill would not reach the monitoring wells until years, possibly decades, after the baseline monitoring is complete.

3.6.1 Baseline Monitoring Parameters

To provide a comprehensive baseline groundwater quality data set, groundwater samples will be collected and filtered in accordance with the Groundwater Sampling Operations Manual (Appendix A) during the baseline monitoring period and analyzed for the following analytes.

- Dissolved priority pollutant metals
- Semivolatile organic compounds
- Volatile organic compounds
- PCBs
- Organochlorine pesticides
- TOC
- Salinity
- Total suspended solids

The baseline TOC and salinity data will allow evaluation of potential changes in general groundwater chemistry (e.g., salt washout) over time. Field parameters (i.e., temperature, pH, electrical conductivity, dissolved oxygen, and turbidity) will also be measured in the field during groundwater sampling.

Analyses will be performed in accordance with analytical methods and quality assurance protocols presented in the Groundwater Sampling Operations Manual (Appendix A).

3.6.2 Baseline Data Evaluation and Reporting

The baseline groundwater quality data will be evaluated to determine whether significant seasonality exists in detected concentrations. Additional samples may be required if data from the 1 year of quarterly monitoring demonstrate significant seasonality. Assuming that seasonality is not present, the baseline data will be summarized statistically to support subsequent data evaluation during compliance monitoring (discussed below).

The baseline groundwater quality conditions will be documented in a report prepared at the end of the baseline monitoring period. This report will present the baseline data collected, assessment of seasonality, and a recommendation on whether the baseline monitoring completed is sufficient to establish baseline conditions. The baseline data will be considered sufficient if they do not show significant seasonality and do not show statistically significant increasing trends over the baseline period.

3.7 Compliance Groundwater Quality Monitoring

The objective of compliance groundwater quality monitoring will be to compare post-construction groundwater quality to baseline conditions and, in turn, to determine whether constituents are being transported from the fill material at concentrations that could pose a potential threat to surface water quality.

Following completion of the baseline monitoring period, the Port and Occidental will submit a proposed compliance monitoring program for the Slip 1 NCD Facility to EPA. The compliance monitoring program will be based on the findings from chemical and leachability testing of sediments placed in the NCD Facility, the post-construction hydrogeologic assessment, and the baseline groundwater quality program. The proposed compliance monitoring program will identify wells to sample, the sampling frequency and schedule, and chemical analyses to be performed.

The wells used for compliance monitoring will be selected based on the determination of the post-construction groundwater flow system (i.e., groundwater flow directions and estimated travel times for the groundwater within the fill to reach the monitoring wells). At a minimum, monitoring well MW6S and MW6D will be monitored. If it is demonstrated that groundwater within the fill would reach one or more of the monitoring wells in substantially shorter times than others, these wells would be selected as indicator wells for compliance monitoring. If statistically significant increases in chemical concentrations are observed in these indicator wells, monitoring of additional wells could be conducted as one of the potential contingency response actions (discussed below). Likewise, during the course of the monitoring program, the Port and Occidental may propose to EPA to reduce the number of monitored wells, based on the data collected up to that time.

Sampling frequency will be determined based on estimated times for groundwater in the fill to reach wells in the monitoring network. At a minimum, monitoring well MW6S and MW6D will be sampled once annually during the first 3 years of compliance monitoring.

Beyond this, a lesser monitoring frequency may be sufficient. As an example, based on the very long estimated groundwater travel times, the first round of compliance monitoring for the Milwaukee Waterway confined disposal facility was completed 5 years after close of the baseline monitoring period for that facility (Port 1997). Because groundwater flow rates are expected to be similarly slow for the Slip 1 NCD Facility, sampling frequencies of 5 or more years may be appropriate for the Slip 1 NCD Facility compliance monitoring program. If statistically significant increases in concentrations of chemicals are observed in the wells, more frequent monitoring could be initiated as one of the potential response actions (discussed below). Likewise, during the course of the monitoring program, the Port and Occidental may propose to EPA to reduce or eliminate the sampling frequency for all or specific analytes based on the data collected up to that time.

The compliance monitoring program will involve sampling and analysis of groundwater for selected indicator chemicals, which are the most mobile chemicals present in sediments to be placed within the Slip 1 NCD Facility. Selection of indicator chemicals will be based on the chemicals in sediments to be placed in the NCD Facility and leachability data that may be available for those sediments. TOC and salinity will be analyzed to track potential general changes in groundwater chemistry over time. Field parameters (i.e., temperature, pH, electrical conductivity, dissolved oxygen, and turbidity) will also be measured in the field during groundwater sampling (see Appendix A).

If statistically significant increases in concentrations of these indicator chemicals are observed, monitoring for additional (less mobile) chemicals could be added as one of the potential response actions (discussed in Section 3.8). Likewise, during the course of the monitoring program, the Port and Occidental may propose to EPA to reduce the analyte list, based on data collected to that time.

3.7.1 Statistical Methods

Procedures for statistical interpretation of groundwater monitoring data will follow the most recent EPA guidance on analyzing groundwater data, including trend analysis (EPA 2009). If the results of these analyses indicate no statistically significant increase in chemical concentrations at individual monitoring wells, the compliance groundwater quality monitoring program will continue as planned, subject to changes proposed by the Port and Occidental or EPA over the course of the program. If statistically significant increases are indicated, the Port and Occidental will propose to EPA that one or more contingency response actions (discussed in Section 3.8) be initiated to further evaluate the potential for site groundwater to adversely impact the adjacent surface water, as described below.

3.8 Future Groundwater Quality Monitoring and Potential Corrective Actions

If statistically significant chemical exceedances of Applicable or Relevant and Appropriate Requirement and/or background concentrations are observed during compliance groundwater quality monitoring of the Slip 1 NCD Facility, contingency response actions will be undertaken upon consultation with EPA. The specific problem that causes the shift to contingency plan will dictate what contingency response action(s) may be most appropriate. Potential contingency response actions could include but not be limited to:

- Resample the well(s) where the increase has been observed to confirm the analytical results.
- Increase the sampling frequency of the existing well(s) of concern and/or other well(s) where increases have not been observed.
- Install new monitoring well(s) closer to the sediment/surface water point of compliance.
- Establish or refine predictive groundwater transport analyses, including tidal mixing, for the chemical(s) of concern to evaluate the potential for exceedance of performance standards at the point of compliance.
- Sample ambient surface water quality to define the appropriate performance standards.
- Complete bioassay testing to evaluate potential for environmental impacts to surface water receptors.
- Implement appropriate remediation techniques to prevent exceedance of the performance standards. Remediation techniques could include in-ground barriers, intrinsic or enhanced bioremediation, groundwater pumping and treatment or reinjection, or other technologies appropriate to the specific situation.

One or more of these contingency response actions, or other actions not listed above but determined to be appropriate in the future, may be warranted depending on the specific groundwater quality conditions indicated by the monitoring data at the time. Based on the data, the Port and Occidental will establish a response plan for discussion with and approval by EPA.

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TABLE

Table 1
Summary of Sediment Stations and Analytes for Natural Recovery Sediment Stability and Protectiveness, and Source Control Monitoring

		Station Coordinates (Washington SP NAD 83 North Zone)		Monitoring Station Type			Parameter	Grain Size	TS and TOC	PCBs	HCB and HCBD	PAHs	Phthalates	DDT and Metabolites	Metals^{1}	Archive
							Container	16-oz Plastic	8-oz WM-G	16-oz WM-G	16-oz WM-G	16-oz WM-G	16-oz WM-G	16-oz WM-G	8-oz WM-G	8-oz WM-G
							Preservative	NA	NA	NA	NA	NA	NA	NA	NA	Frozen
OMMP Station ID	Historical Station ID	Northing (ft)	Easting (ft)	Sediment Recovery	Subsurface Protectiveness	Source Control	Laboratory Sample ID									
Segment 5 Channel																
OMMP-1	HY-506	717485.6	1166445	--	--	X	OMMP-1-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-2	HY-509	717100.8	1166655.5	--	--	X	OMMP-2-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-3	HY-512	716625.358	1167142.204	--	X	X	OMMP-3-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-4	HY-514	716331.975	1167453.242	X	--	--	OMMP-4-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-5	HY-516	716172.555	1167603.329	X	--	--	OMMP-5-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-6	HY-519	716034.358	1167747.187	X	--	--	OMMP-6-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-7	HY-522	715850.766	1168068.774	X	--	--	OMMP-7-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-10	HY-523	715666.273	1168322.085	--	X	X	OMMP-10-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-12	HY-525	715498.338	1168265.267	X	--	--	OMMP-12-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-16	HY-527	715149.203	1168604.744	X	--	--	OMMP-16-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-17	HY-528	715231.988	1168824.909	X	--	--	OMMP-17-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-18	HY-530	715086.74	1169178.51	X	--	--	OMMP-18-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-21	HY-533	714736.676	1169585.697	X	--	--	OMMP-21-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-22	HY-535	714644.429	1169874.518	X	--	X	OMMP-22-YYMMDD	X	X	X	X	X	X	X	X	X
Chinook Marina																
OMMP-8	IHS-22	716002.402	1168246.017	X	--	--	OMMP-8-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-9	5125	715975.097	1168358.425	X	--	--	OMMP-9-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-11	IHS-21	715954.52	1168630.904	X	--	--	OMMP-11-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-13	IHS-8	715751.932	1168513.507	X	--	--	OMMP-13-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-14	5126	715695.676	1168627.633	X	--	--	OMMP-14-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-15	IHS-23	715574.693	1168772.445	X	--	--	OMMP-15-YYMMDD	X	X	X	X	X	X	X	X	X
Navy Bank Nearshore																
OMMP-19	2S	714798.688	1169084.511	X	--	--	OMMP-19-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-20	3S	714745.565	1169227.108	X	--	--	OMMP-20-YYMMDD	X	X	X	X	X	X	X	X	X
Tacoma Public Nearshore																
OMMP-24	402	714464.738	1170227.295	X	--	--	OMMP-24-YYMMDD	X	X	X	X	X	X	X	X	X
Segement 4 Channel																
OMMP-23	HY-536	714771.4	1169976.32	--	--	X	OMMP-23-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-25	HY-421-2	714235	1171115.4	--	--	X	OMMP-25-YYMMDD	X	X	X	X	X	X	X	X	X
American Nearshore																
OMMP-26	AMCO-C24	713949	1171516	X	--	--	OMMP-26-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-27	AMCO-C11b	713852.272	1171537.975	X	--	--	OMMP-27-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-28	AMCO-C11b	713887	1171559	X	--	--	OMMP-28-YYMMDD	X	X	X	X	X	X	X	X	X
Simons Nearshore																
OMMP-31	401-C	713813.816	1171905.057	X	--	--	OMMP-31-YYMMDD	X	X	X	X	X	X	X	X	X

Table 1
Summary of Sediment Stations and Analytes for Natural Recovery Sediment Stability and Protectiveness, and Source Control Monitoring

OMMP Station ID	Historical Station ID	Station Coordinates (Washington SP NAD 83 North Zone)		Monitoring Station Type			Parameter	Grain Size	TS and TOC	PCBs	HCB and HCBD	PAHs	Phthalates	DDT and Metabolites	Metals[1]	Archive
							Container	16-oz Plastic	8-oz WM-G	16-oz WM-G	16-oz WM-G	16-oz WM-G	16-oz WM-G	16-oz WM-G	8-oz WM-G	8-oz WM-G
							Preservative	NA	NA	NA	NA	NA	NA	NA	NA	Frozen
		Northing (ft)	Easting (ft)	Sediment Recovery	Subsurface Protectiveness	Source Control	Laboratory Sample ID									
Simons Channel																
OMMP-29	--	714079.09	1171791.74	X	--	--	OMMP-29-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-30	401-D	713970.935	1171949.383	--	X	--	OMMP-30-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-32	--	713855.831	1172172.339	X	--	--	OMMP-32-YYMMDD	X	X	X	X	X	X	X	X	X
Sound Refining Schoaling Area																
OMMP-33	HY-S44-1	713817.187	1172566.16	X	--	X	OMMP-33-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-35	HY-S44-5	713619.074	1173053.427	X	--	X	OMMP-35-YYMMDD	X	X	X	X	X	X	X	X	X
Buffelen Embankment																
OMMP-34	BEA-C04-1	713391.255	1172706.309	X	--	--	OMMP-34-YYMMDD	X	X	X	X	X	X	X	X	X
Murray-Pacific Channel																
OMMP-36	HY-321-1	713273.138	1173320.585	--	X	X	OMMP-36-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-37	301	713127.185	1173456.273	X	--	--	OMMP-37-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-38	HY-322-2	712708.587	1173906.12	--	X	X	OMMP-38-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-39	HY-322-4	712370.21	1174331.91	--	X	X	OMMP-39-YYMMDD	X	X	X	X	X	X	X	X	X
Wasser Winters Nearshore																
OMMP-40	103	708711.526	1178726.323	X	--	--	OMMP-40-YYMMDD	X	X	X	X	X	X	X	X	X

Notes:

-- = not applicable

1 = Metals parameters include arsenic, cadmium, chromium, copper, mercury, nickel, lead, silver, and zinc.

DDT = dichlorodiphenyl-trichloroethane

ID = identification

ft = foot

HCB = hexachlorobenzene

HCBD = hexachlorobutadiene

NA = not applicable

oz = ounce

PAH = polycyclic aromatic hydrocarbons

PCB = polychlorinated biphenyls

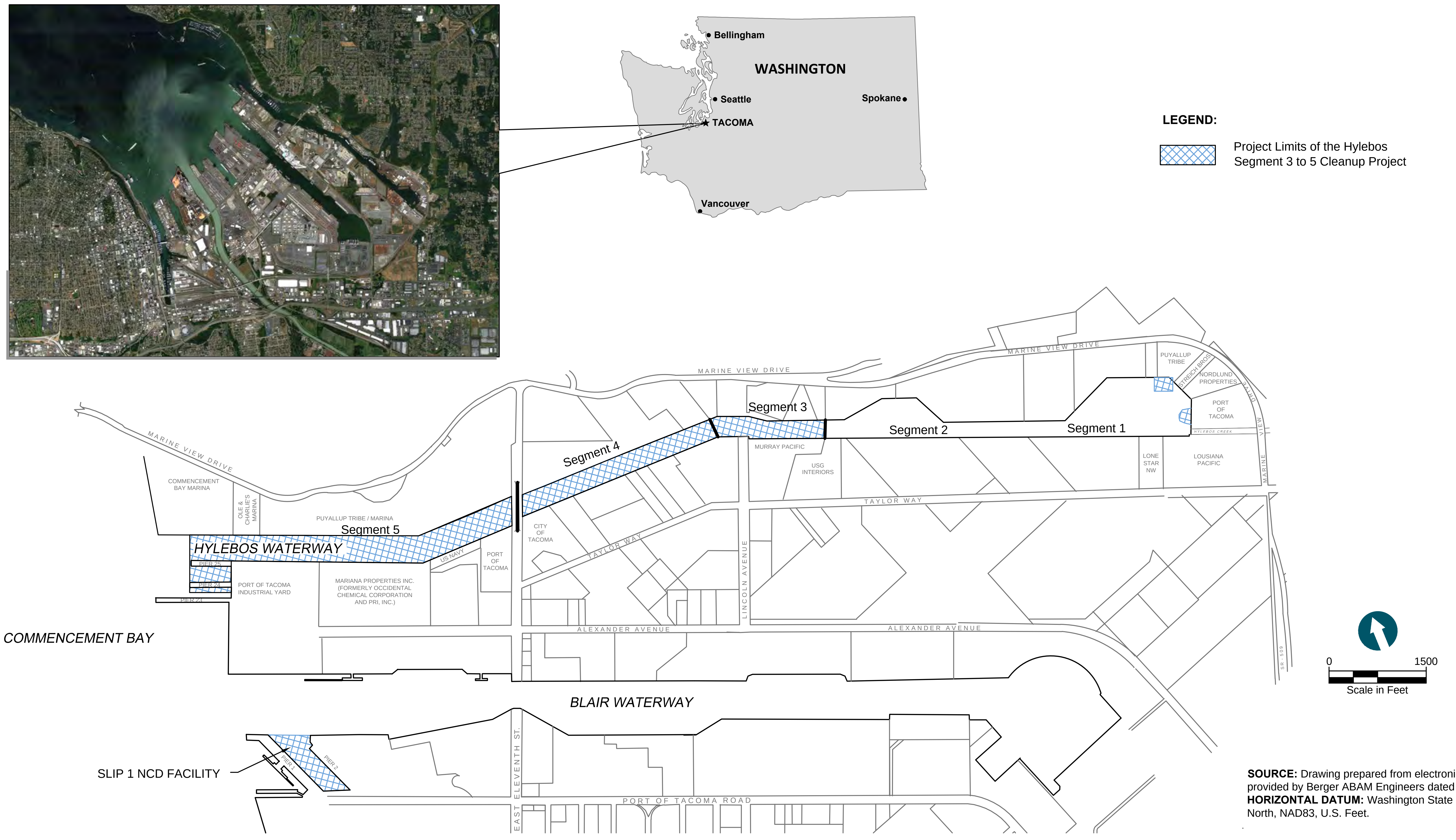
TS = total solids

TOC = total organic carbon

Washington SP NAD 83 = Washington State Plane North American Datum 1983

WM-G = wide-mouth glass jar

FIGURES



LEGEND:

▨ Project Limits of the Hylebos Segment 3 to 5 Cleanup Project

SOURCE: Drawing prepared from electronic file provided by Berger ABAM Engineers dated 2003.
HORIZONTAL DATUM: Washington State Plane North, NAD83, U.S. Feet.

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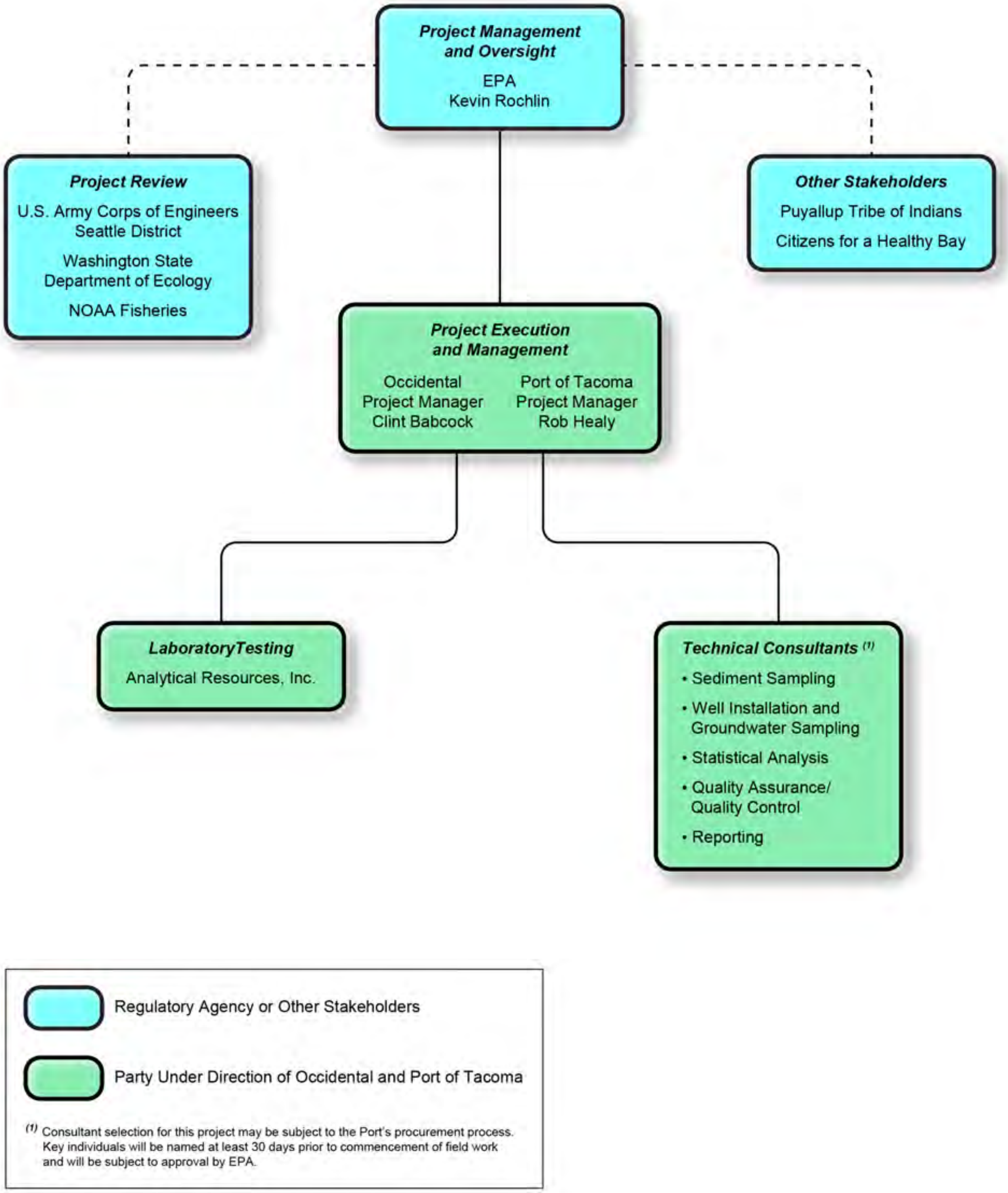
ANCHOR QEA

Figure 1
Vicinity Map
Mouth of Hylebos Waterway (Segments 3, 4, and 5)

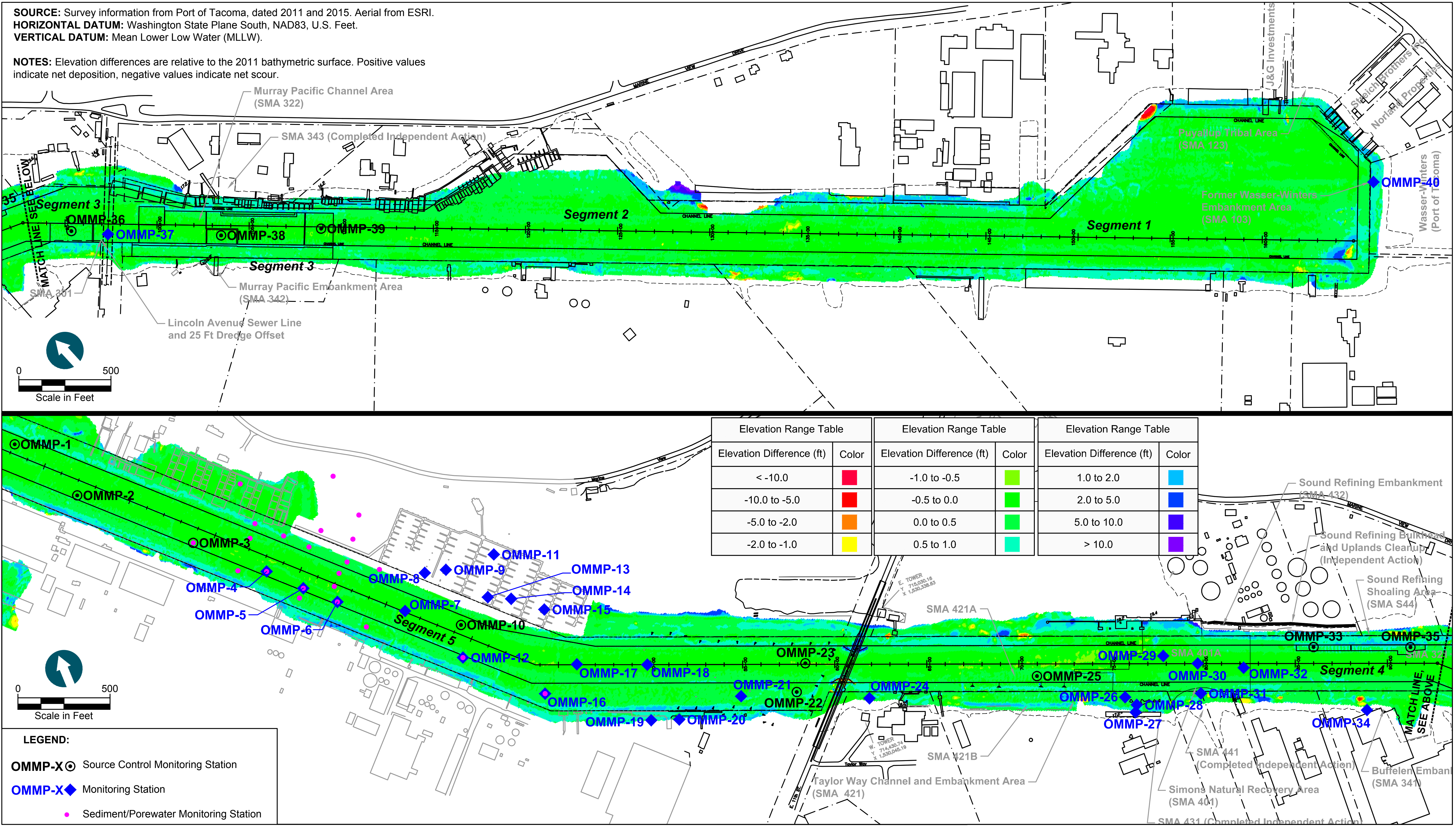


(1) Consultant selection for this project may be subject to the Port's procurement process. Key individuals will be named at least 30 days prior to commencement of field work and will be subject to approval by EPA.

Figure 2
Organization Chart for Mouth of Hylebos OMMP
Mouth of Hylebos Waterway (Segments 3, 4, and 5)

SOURCE: Survey information from Port of Tacoma, dated 2011 and 2015. Aerial from ESRI.
HORIZONTAL DATUM: Washington State Plane South, NAD83, U.S. Feet.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

NOTES: Elevation differences are relative to the 2011 bathymetric surface. Positive values indicate net deposition, negative values indicate net scour.



Elevation Range Table	
Elevation Difference (ft)	Color
< -10.0	🟥
-10.0 to -5.0	🟥
-5.0 to -2.0	🟧
-2.0 to -1.0	🟨

Elevation Range Table	
Elevation Difference (ft)	Color
-1.0 to -0.5	🟩
-0.5 to 0.0	🟩
0.0 to 0.5	🟩
0.5 to 1.0	🟦

Elevation Range Table	
Elevation Difference (ft)	Color
1.0 to 2.0	🟦
2.0 to 5.0	🟦
5.0 to 10.0	🟪
> 10.0	🟪

LEGEND:

OMMP-X ⊙	Source Control Monitoring Station
OMMP-X ◆	Monitoring Station
●	Sediment/Porewater Monitoring Station

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ANCHOR QEA

Figure 3
Mouth of Hylebos Sediment Monitoring Locations
Mouth of Hylebos Waterway (Segments 3, 4, and 5)

Source: Google Earth Aerial - September 29, 2015

720 S. 333rd St, Ste. 210
Federal Way, WA 98003
office: 253-661-3520
cel/direct: 253-266-2838
www.greylockenv.com

GREYLOCK CONSULTING LLC

Water Resources & Environmental Services

LEGEND

APPROXIMATE BOUNDARY OF SLIP 1 NCD

○ **EXISTING MONITORING WELL LOCATION AND NUMBER**

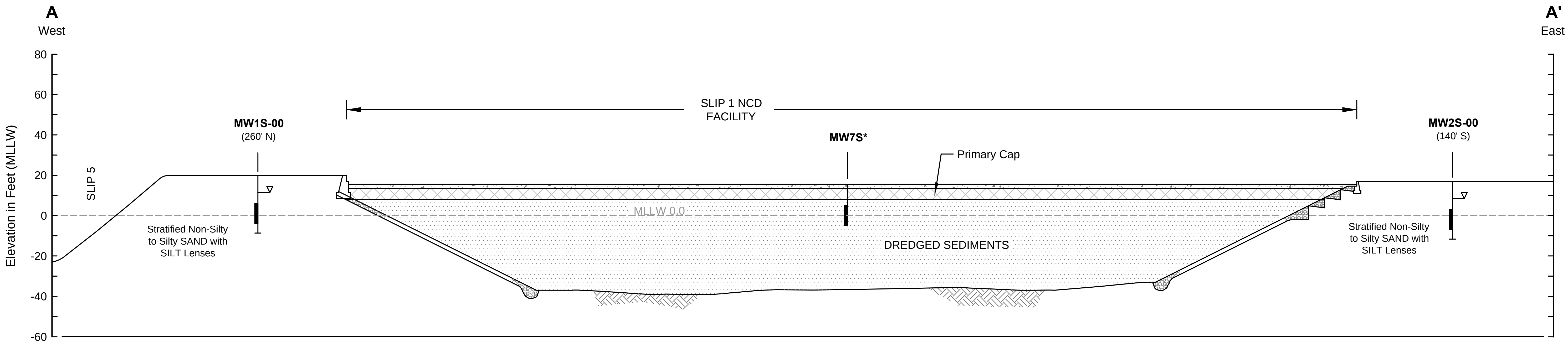
● **PROPOSED MONITORING WELL LOCATION AND NUMBER**

N
W E
S

0 150 300
SCALE IN FEET

FIGURE 4 : SLIP 1 NCD FACILITY GROUNDWATER MONITORING WELL LOCATIONS

Project : Mouth of Hylebos Cleanup Project
Location : Sitcum Peninsula, Port of Tacoma
Client : Port of Tacoma and Occidental Chemical
Project No : 13-0448



LEGEND:

MW1S-00
(260' N)

Monitoring Well Location and Number
Offset Distance and Direction
* = Proposed Monitoring Well

Average Groundwater Level from 72-hour Tidal Study (CRA 2000b)

Screened Interval

Cross Section location shown on Figure 3.

0 50
Scale in Feet

HORIZONTAL DATUM: Washington State Plane South, NAD83, U.S. Feet.

NOTE:
Contacts between soil units are based upon interpolation between borings and represent our interpretation of subsurface conditions based on currently available data.

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Figure 5
Slip 1 NCD Facility Cross Section A-A'
Mouth of Hylebos Waterway (Segments 3, 4, and 5)

APPENDIX A
GROUNDWATER SAMPLING OPERATIONS MANUAL

APPENDIX A

GROUNDWATER SAMPLING OPERATIONS MANUAL

MOUTH OF HYLEBOS WATERWAY (SEGMENTS 3, 4, AND 5)

TACOMA, WASHINGTON

Prepared for

Occidental Chemical Corporation

and

Port of Tacoma

Prepared by

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720 Olive Way, Suite 1900
Seattle, Washington 98101

December 2015

A.1 INTRODUCTION

This groundwater sampling operations manual describes general sampling and analysis procedures to monitor groundwater conditions in existing and new wells in the Slip 1 Nearshore Confined Disposal (NCD) Facility area, located along the Blair Waterway at what is currently referred to as Port of Tacoma's (Port's) Husky Terminal (also referred to as Pier 3 or Terminal 3/4). As discussed in the Operations, Maintenance, and Monitoring Plan (OMMP), five new shallow wells (MW5S, MW6S, MW7S, MW8S, and MW9S) and three new deep wells (MW6D, MW8D, and MW9D) will be installed around and within the Slip 1 NCD Facility using the same procedures used to install existing wells MW1S-00 and MW2S-00. The final well installation and groundwater sampling operations manual will be prepared by the contractor and provided to the U.S. Environmental Protection Agency (EPA) for review and approval prior to initiating field activities. Table A-1 provides a summary of well construction details of existing and proposed monitoring wells at the Slip 1 NCD. Prior to installation of new wells, a condition survey of the existing monitoring wells will be performed. Well locations will be surveyed, the condition of the surface seal will be assessed, the amount of silt in the wells will be measured, and depth to water will be measured.

The objective of long-term monitoring of groundwater quality in the vicinity of the Slip 1 NCD Facility is to demonstrate protection of surface water. Future changes in transitioning from baseline monitoring to compliance monitoring (such changes in wells to be sampled, sampling frequency, or chemical analyses) will be described in addenda to this manual.

This manual is organized in two general sections: Preparation for Sampling, Sampling Procedures, and Post-Sampling Procedures. Attachment A-1 presents the Quality Assurance Project Plan (QAPP) for this project. A copy of this Groundwater Sampling Operations Manual should be carried in the field when completing this groundwater sampling. The contractor completing the groundwater monitoring will be responsible for following their site-specific health and safety plan.

A.2 PREPARATION FOR SAMPLING

Before going to the field, the following steps should be completed.

1) Review this Manual

Become familiar with this Sampling Operating Procedure, including QAPP requirements. If any questions arise, ask the Project Manager.

2) Contact Appropriate People for Site Access

Notify the Port and Occidental Chemical Corporation's (Occidental) Project Manager of sampling schedule. In addition, at least 48 hours in advance, notify the person responsible for site access (Port Project Manager) of the sampling schedule and ask for permission to access the site. Also ask for removal of containers or other equipment that may be obstructing access to the wells.

3) Contact Analytical Laboratory

A Laboratory Services Work Order will be completed for each groundwater sampling event. As an attachment to the Work Order, analytical methods, sample quantitation limits, and quality control desired for each analysis will be specified (including a separate copy of the QAPP to the lab). Any deviations from these requirements by the laboratory will have to be approved beforehand by the Port and Occidental or their designee (consultant).

At least one week before the sampling event, the analytical laboratory will be notified about:

- Date of sampling and date of sample delivery to lab
- Number of samples to be collected
- Tests to be performed (confirm with the lab whether you will be filtering samples for dissolved metals in the field)
- When bottles are needed (with cooler, blue ice, and chain-of-custody form)

4) Ensure Field Equipment Is Working and Calibrated

The required equipment includes the following:

- Key/tools necessary to access wells
- Equipment for low-flow/low-turbidity sampling to minimize the suspension of sediment into samples (e.g., peristaltic or bladder pumps and disposable polyethylene tubing)
- Well sounder for water level measurements

- Field parameter probe(s) for measuring temperature (T), pH, electrical conductivity (EC), dissolved oxygen (DO), and turbidity, along with flow-through cell
- Graduated container and stop watch for measuring well purging rate
- Truck to haul equipment and supplies during sampling

The required supplies, new for each sampling event, include the following:

- Field forms and chain-of-custody form
- Plastic sheeting, garbage bags, and paper towels
- Deionized (DI) water pump sprayer
- Personal protective equipment as specified in the contractor's site-specific Health and Safety Plan
- Laboratory-supplied sample bottles
- In-line filters for dissolved metals sampling
- Blue ice and cooler

The field parameter meter(s) should be calibrated on the day of sampling using commercially available calibration solutions and following the instrument manufacturers' directions.

5) Know Where to Go

A map of the Slip 1 NCD Facility and the monitoring well location map is provided on Figure 4 of the OMMP.

A.3 GROUNDWATER SAMPLING PROTOCOL

Upon arrival to the site, clear access with person(s) responsible for controlling site access. The order of well sampling is not critical. Cross contamination is not expected if good field practices are used. Therefore, the order of well sampling is left to the discretion of the field representative.

Inspect the area surrounding the well. If a well monument is blocked with containers or other objects, contact the person responsible for site access to clear the well location for you. Once the well is accessible, the following field sampling procedures will be completed.

1) Measure Depth to Water

1. Open protective casing. Comment on field log about monument/well conditions.
2. Remove discharge tube and screw it into the male adapter.
3. Decontaminate well sounder by rinsing with DI water.
4. Drop sounder probe into hole where discharge tube was kept and determine water level by means of light emitting diode or beeper. Measure mark on the probe to the nearest 0.01 foot using a tape measure. Record this value, with date and time, on the field log as the static depth to water.

2) Purge Well

1. The wells will be purged consistent with the most recent, published EPA guidance document (Puls and Barcelona 1996), using low-flow/low-turbidity sampling equipment (e.g., peristaltic pumps and disposable polyethylene tubing). Intake tubing will be placed at the mid-point of the screened interval of each well during purging. Tubing will be positioned at the same depth during each purging and sampling event. Field parameters will be monitored during purging to determine when groundwater sampling may begin (e.g., stable T, pH, EC and DO; achievement of turbidity levels less than 5 Nephelometric Turbidity Unit [NTU]).
2. Begin purging the well. During the first sampling, purge and decontamination water will be stored and tested prior to final disposition. If the first round sampling data verify the lack of groundwater contamination, purge water collected during subsequent sampling events may be discharged to the ground. Adjust the discharge tube so that the water runs away from the wellhead to the extent possible.
3. Purge the well at low flow rates not to exceed 0.5 liter per minute (determined by measuring the time to fill a known volume). The purge rate can be increased to 1 liter per minute if the purge water is observed to be non-turbid (e.g., less than 5 NTU) <u>and</u> the purging creates less than 0.5 foot of drawdown in the well.
4. During purging, measure field parameters (T, pH, EC, DO, and turbidity) in the purge water at 3- to 5-minute intervals. Record the time and parameter values and purge rate, on the field log for each set of readings. If the field measurements for turbidity, DO, and EC are approximately stable (± 10%) for three consecutive readings, the groundwater sample will be collected. If DO is below 5 milligrams per liter (mg/L), three consecutive

readings of ±1 mg/L will be considered stable. Should the turbidity readings be negative values, the measurement will be recorded as less than 1 (< 1). If the field parameter meter also measures salinity, it should be recorded, but it will not be a stabilization parameter. Depth to water will be measured and recorded during the first 5 minutes of purging, to calculate drawdown, as discussed above. Because these field parameters (particularly turbidity) may not reach these stringent stabilization criteria at a particular well, collection of each groundwater sample will be based on the field personnel's best professional judgment at the time of sampling. No more than three casing volumes will be purged prior to sample collection. The last set of field parameters measured during purging will represent field parameters for the groundwater sample.

5. Record all field measurements and observations legibly on the field forms, as these forms will be included as appendices in the monitoring reports.

3) Bottle Labeling

Before or during well purging, label the bottles provided by the lab. The sample number format will be "well number—month/year of collection." For example, a sample collected from well MW1S-00 on September 15, 2013, would be labeled MW1S-00-9/13.

In this way, every groundwater sample has a unique identifier, and the collection date (month) is known from the sample number. Other information to include on bottle label is date, time, and initials of sampler.

4) Sample Collection

1. After purging the well and labeling the bottles, collect the groundwater sample by directly filling the lab-provided bottles from the pump discharge line (maintain same flow rate as purging). In this way, only dedicated materials are used in sampling, and there is no need for equipment decontamination (other than the well sounder). The specific bottles to be filled for each chemical analysis will be communicated by the laboratory.
2. Immediately place all labeled, filled bottles in coolers packed with blue ice, as provided by the lab.

5) Leaving the Well

1. Turn off the pump.
2. Disconnect hose connecting the well to the pump.
3. Inform the person responsible for your site access that you are leaving the premises.

A.4 POST-SAMPLING PROCEDURES

A chain-of-custody form will be included with the sample bottles supplied by the laboratory. The custody form will be filled out by the sampler, indicating chemical analyses to be performed, date of sample collection, matrix (water), number of bottles per sample, method of delivery, standard turnaround time, etc. as specified on the form. Reference on the chain-of-custody form to a laboratory services work order will help ensure that project-specific requirements (e.g., analytical methods, sample quantitation limits, QA/QC requirements) are completed by the laboratory. The chain-of-custody form must accompany the samples at all times, documenting each change of possession.

On the custody form, specify that the report be sent electronically to the following:

Rob Healy at rhealy@portoftacoma.com and Clint Babcock at clint_babcock@oxy.com.

Hard copies should be sent to the following addresses:

Port of Tacoma
Attn: Rob Healy
P.O. Box 1837
Tacoma, Washington 98401-1837
Phone: (253) 428-8643

Glenn Springs Holdings
Attn: Clint Babcock
5005 LBJ Freeway, Suite 1350
Dallas, Texas 75244-6119
Phone: (972) 687-7506

The samples should be delivered to the laboratory as soon as possible following collection.

REFERENCE

Puls, R.W., and M.J. Barcelona, 1996. Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. U.S. Environmental Protection Agency Ground Water Issue. EPA/540/S-95-504. April 1996.

TABLE

Table A-1
Description of Existing[1] and Proposed Monitoring Wells at Slip 1 NCD

Well Identification	Existing or Proposed	Construction Method/ Development Method	Well Diameter/ Well Material	Depth to Bottom of Well (ft bgs)	Screen Slot Size/Length	Screened Interval (ft bgs)	Filter Pack Gradation/ Interval (ft bgs)	Screened Interval (Elevation in ft above MLLW)	Surface and Annular Seal Material
MW1S-00	Existing	Hollow-stem auger/pumping	2-inch/PVC	24.0	0.010/10 ft	14.0 to 24.0	#20 Silica sand/ 12.0 to 24.0	4.48 to -5.52	Concrete: 0 to 2.5 ft bgs; bentonite: 2.5 to 12.0 ft bgs
MW2S-00	Existing	Hollow-stem auger/pumping	2-inch/PVC	24.0	0.010/10 ft	14.0 to 24.0	#20 Silica sand/ 12.0 to 24.0	3.30 to -6.70	Concrete: 0 to 2.5 ft bgs; bentonite: 2.5 to 12.0 ft bgs
MW3D-00	Existing	Hollow-stem auger/pumping	2-inch/PVC	74.0	0.010/10 ft	64.0 to 74.0	#20 Silica sand/ 61.0 to 74.0	-45.84 to -55.84	Concrete: 0 to 2.5 ft bgs; bentonite: 2.5 to 61.0 ft bgs
MW4S-00	Existing	Hollow-stem auger/pumping	2-inch/PVC	24.0	0.010/10 ft	14.0 to 24.0	#20 Silica sand/ 12.0 to 24.0	3.83 to -6.17	Concrete: 0 to 2.5 ft bgs; bentonite: 2.5 to 12.0 ft bgs
HCC-1	Existing	Hollow-stem auger/no information on development	2 inch/ Schedule 40 stainless steel	25.0	0.010/10 ft	15.0 to 25.0	10 to 20 Silica sand/ 14.0 to 25.0	No Survey Information Available	Concrete: At surface, but no information on thickness; bentonite to 14.0 ft bgs.
MW5S	Proposed	Hollow-stem auger/pumping	2-inch/PVC	24.0	0.010/10 ft	14.0 to 24.0	#20 Silica sand/ 12.0 to 24.0	Approximately 4 to -6	Concrete: 0 to 2.5 ft bgs; bentonite: 2.5 to 12.0 ft bgs
MW6S	Proposed	Hollow-stem auger/pumping	2-inch/PVC	24.0	0.010/10 ft	14.0 to 24.0	#20 Silica sand/ 12.0 to 24.0	Approximately 4 to -6	Concrete: 0 to 2.5 ft bgs; bentonite: 2.5 to 12.0 ft bgs
MW7S	Proposed	Hollow-stem auger/pumping	2-inch/PVC	24.0	0.010/10 ft	14.0 to 24.0	#20 Silica sand/ 12.0 to 24.0	Approximately 4 to -6	Concrete: 0 to 2.5 ft bgs; bentonite: 2.5 to 12.0 ft bgs
MW8S	Proposed	Hollow-stem auger/pumping	2-inch/PVC	24.0	0.010/10 ft	14.0 to 24.0	#20 Silica sand/ 12.0 to 24.0	Approximately 4 to -6	Concrete: 0 to 2.5 ft bgs; bentonite: 2.5 to 12.0 ft bgs
MW9S	Proposed	Hollow-stem auger/pumping	2-inch/PVC	24.0	0.010/10 ft	14.0 to 24.0	#20 Silica sand/ 12.0 to 24.0	Approximately 4 to -6	Concrete: 0 to 2.5 ft bgs; bentonite: 2.5 to 12.0 ft bgs
MW6D	Proposed	Hollow-stem auger/pumping	2-inch/PVC	57.0	0.010/10 ft	47.0 to 57.0	#20 Silica sand/ 44.0 to 57.0	Approximately -28 to -38[2]	Concrete: 0 to 2.5 ft bgs; bentonite: 2.5 to 44.0 ft bgs
MW8D	Proposed	Hollow-stem auger/pumping	2-inch/PVC	57.0	0.010/10 ft	47.0 to 57.0	#20 Silica sand/ 44.0 to 57.0	Approximately -28 to -38[2]	Concrete: 0 to 2.5 ft bgs; bentonite: 2.5 to 44.0 ft bgs
MW9D	Proposed	Hollow-stem auger/pumping	2-inch/PVC	57.0	0.010/10 ft	47.0 to 57.0	#20 Silica sand/ 44.0 to 57.0	Approximately -28 to -38[2]	Concrete: 0 to 2.5 ft bgs; bentonite: 2.5 to 44.0 ft bgs

Notes:
ft = foot
ft bgs = feet below ground surface
MLLW = mean low low water
1 Information is based on available well logs.
2 Approximate elevation of the bottom of Slip 1 NCD, based on 100% Design

ATTACHMENT A-1

QUALITY ASSURANCE PROJECT PLAN FOR GROUNDWATER QUALITY ANALYSIS

MOUTH OF HYLEBOS WATERWAY (SEGMENTS 3, 4, AND 5)

TACOMA, WASHINGTON

December 2015

QUALITY ASSURANCE PROJECT PLAN APPROVALS

Project Execution and Management:

Clint Babcock (Glenn Springs Holdings)	Robert Healy (Port of Tacoma)

Groundwater Sampling Project Manager:

Name
Affiliation

Field Coordinator:

Name
Affiliation

QA/QC Manager:

Name
Affiliation

Laboratory:

Name
Affiliation

QUALITY ASSURANCE PROJECT PLAN FOR GROUNDWATER QUALITY ANALYSIS

Introduction

The purpose of this Quality Assurance Project Plan (QAPP) is to give, in specific terms, the objectives, organization, and functional activities, associated with the groundwater quality monitoring for the Slip 1 Nearshore Confined Disposal (NCD) Facility as a component of the Hylebos Cleanup in Tacoma, Washington. The groundwater quality monitoring program was developed to assess the potential for impacts to the local surface water via transport of contaminants in groundwater flowing from the Slip 1 NCD Facility.

This QAPP was prepared following the U.S. Environmental Protection Agency's (EPA) QAPP guidance documents (EPA 2002). This document is consistent with and meets the intent of these guidelines. In addition, a number of other EPA documents were used as aids in preparing this document (EPA 1980, 1986, 1987, 1989).

Quality Assurance Objective

The quality assurance (QA) objective for this project is to ensure that the data collected are of known and acceptable quality so that the goal of the groundwater quality monitoring program can be achieved. The groundwater quality monitoring goal is long-term protection of surface water by demonstrating that groundwater quality around the Slip 1 NCD Facility is not being adversely impacted. The point of compliance for surface water protection is the sediment/surface water interface, not at the groundwater monitoring wells proposed for monitoring. The quality of the laboratory data is assessed by precision, accuracy, representativeness, comparability, and completeness (the "PARCC" parameters). Definitions of these parameters and the applicable quality control (QC) procedures are given below. Applicable quantitative goals for these data quality parameters are listed or referenced in Tables A-1-1 and A-1-2. Laboratory activities shall be conducted in such a manner that the results meet specified quality objectives and are fully defensible. Guidance for laboratory QA/QC is derived from the protocols developed for the EPA Contract Laboratory Program (EPA 2004, 2008).

Contract Laboratory Requirements

In completing chemical analyses for this project, the contract laboratories are expected to meet the following minimum requirements:

1. Adhere to the methods outlined in the QAPP, including methods referenced for each analytical procedure.
2. Deliver fax, hard copy, and electronic data (Environmental Information Management [EIM] compatible for submittal to Washington State Department of Ecology) as specified.
3. Meet reporting requirements for deliverables.
4. Meet turnaround times for deliverables.
5. Implement QA/QC procedures, including the QAPP data quality requirements, laboratory QA requirements, and performance evaluation testing requirements.
6. Allow laboratory and data audits to be performed, if deemed necessary.

Chemical Analyses for Baseline Groundwater Monitoring

Groundwater samples collected during the baseline monitoring period will be submitted for chemical analysis of the following:

- Dissolved priority pollutant metals (EPA Method 200.8
- Semivolatile organic compounds (SVOCs; EPA Method 8270)
- Volatile organic compounds (VOCs; EPA Method 8260)
- Polychlorinated biphenyls (PCBs; EPA Method 8082)
- Organochlorine (OC) pesticides (EPA Method 8081A)
- Total organic carbon (EPA Method 415.1)
- Salinity (SM 2520)
- Total suspended solids (EPA Method 160.2)

Table A-1-1 presents the method of analysis and water quality objectives for groundwater samples.

Analytes for groundwater compliance monitoring will be decided at the end of the baseline monitoring period, as described in the Operations, Maintenance, and Monitoring Plan.

Reporting Limits

Prior to the analysis of the samples, the laboratory will calculate method detection limits for each analyte of interest. Method detection limits will be below the water quality criteria specified in Table A-1-1, if technically feasible. To achieve the required detection limits, some modifications to the methods may be necessary. These modifications from the specified analytical methods will be provided by the laboratory at the time of establishing the laboratory contract, and must be approved by the EPA prior to implementation.

Laboratory Quality Assurance Objectives

Precision

Precision measures the reproducibility of measurements under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average values. Analytical precision is measured through matrix spike/matrix spike duplicate (MS/MSD) samples for organic analysis and through laboratory duplicate samples for inorganic analyses.

Analytical precision measurements will be carried out on project-specific samples at a minimum frequency of one per laboratory analysis group or one in twenty samples, whichever is more frequent per matrix analyzed, as practical. Laboratory precision will be evaluated against quantitative relative percent difference (RPD) performance criteria provided by the laboratory.

Field precision will be evaluated by the collection of blind field duplicates at a frequency of 20 percent. Field duplicate precision will be screened against an RPD of 50 percent for groundwater samples. However, no data will be qualified based solely on field duplicate precision.

Precision measurements can be affected by the nearness of a chemical concentration to the method detection limit, where the percent error (expressed as RPD) increases. The equations used to express precision are as follows:

$$RPD = \frac{(C_1 - C_2) x \ 100\%}{(C_1 + C_2)/2}$$

where:

RPD = relative percent difference

C_1 = larger of the two observed values

C_2 = smaller of the two observed values

Accuracy

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Field accuracy is controlled by adherence to sample collection procedures outlined in the Groundwater Sampling Manual.

Analytical accuracy may be assessed by analyzing “spiked” samples with known standards (surrogates, laboratory control samples, or matrix spike) and measuring the percent recovery. Accuracy measurements on matrix spike samples will be carried out at a minimum frequency of 1 in 20 samples per matrix analyzed. Because MS/MSDs measure the effects of potential matrix interferences of a specific matrix, the laboratory will perform MS/MSDs only on samples from this investigation and not from other projects. Surrogate recoveries will be determined for every sample analyzed for organics.

Laboratory accuracy will be evaluated against quantitative matrix spike and surrogate spike recovery performance criteria provided by the laboratory. Accuracy can be expressed as a percentage of the true or reference value, or as a percent recovery in those analyses where reference materials are not available and spiked samples are analyzed. The equation used to express accuracy is as follows:

$$\%R = 100\% \; x \; (S - U)/C_{sa}$$

where:

$\%R$ = percent recovery

S = measured concentration in the spiked aliquot

U = measured concentration in the unspiked aliquot

C_{sa} = actual concentration of spike added

The equation used to express surrogate recovery performance is as follows:

$$\%R = 100\% \; x \; (U/S)$$

where:

$\%R$ = percent recovery

S = measured concentration in the spiked aliquot

U = measured concentration in the unspiked aliquot

Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition. For this baseline monitoring program, the list of analytes has been identified to provide a comprehensive assessment of baseline groundwater quality.

Comparability

Comparability expresses the confidence with which one data set can be evaluated in relation to another data set. For this program, comparability of data will be established through the use of standard analytical methodologies and reporting formats and of common traceable calibration and reference materials.

Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

$$C = \frac{(Number\ of\ acceptable\ data\ points)\ x\ 100}{(Total\ number\ of\ data\ points)}$$

The data quality objective for completeness for all components of this project is 90 percent. Data that have been qualified as estimated because the quality control criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

Quality Control Procedures

Sampling procedures for this investigation are described in detail in the Groundwater Sampling Operations Manual for this project. Table A-1-2 presents the field sample preservation and holding time information.

Field Quality Control Procedures

Field sampling and documentation procedures are detailed in the Groundwater Sampling Manual. To control the quality of field samples, field duplicate of groundwater will be collected at 20 percent frequency. Their analysis is useful in identifying possible problems resulting from sample collection or sample processing in the field. A trip blank will be collected during groundwater sampling and analyzed for VOCs. All field quality control samples will be documented in the field logbook and verified by the QA Manager, or designee.

Laboratory Quality Control Procedures

Laboratory Quality Control Criteria. Results of the quality control samples from each sample group will be reviewed by the analyst immediately after a sample group has been analyzed. The quality control sample results will then be evaluated to determine if control limits have been exceeded. If control limits are exceeded in the sample group, the Project QA Manager will be contacted immediately, and corrective action (e.g., method modifications followed by reprocessing the affected samples) will be initiated prior to processing a subsequent group of samples.

All primary chemical standards and standard solutions used in this project will be traceable to documented, reliable, commercial sources. Standards will be validated to determine their accuracy by comparison with an independent standard. Any impurities found in the standard will be documented.

The following sections summarize the procedures that will be used to assess data quality throughout sample analysis.

Initial and Continuing Calibration. Multipoint initial calibration will be performed on each instrument at the start of the project, after each major interruption to the analytical instrument, and when any ongoing calibration does not meet control criteria. Ongoing calibration will be performed daily for metals and organic analyses and with every sample batch for conventional parameters (when applicable) to track instrument performance.

Instrument blanks or continuing calibration blanks provide information on the stability of the baseline established. Continuing calibration blanks will be analyzed immediately prior to continuing calibration verification at a frequency of 1 continuing calibration blank for every 10 samples analyzed at the instrument for inorganic analyses and every 21 hours for organic analyses. If the ongoing calibration is out of control, the analysis must come to a halt until the source of the control failure is eliminated or reduced to meet control specifications.

All project samples analyzed while instrument calibration was out of control will be reanalyzed.

Laboratory Duplicates. Analytical duplicates provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Analytical duplicates are subsamples of the original sample that are prepared and analyzed as a separate sample. A minimum of one duplicate will be analyzed per sample group or for every 20 samples, whichever is more frequent.

Matrix Spikes and Matrix Spike Duplicates (MS/MSD). Analysis of matrix spike samples provides information on the extraction efficiency of the method on the sample matrix. By performing duplicate matrix spike analyses, information on the precision of the method is also provided for organic analyses. A minimum of one MS/MSD will be analyzed for every sample group or for every 20 samples, whichever is more frequent, when possible.

Surrogate Spikes. All project samples analyzed for organic compounds will be spiked with appropriate surrogate compounds as defined in the analytical methods. Surrogate recoveries will be reported by the laboratories; however, no sample result will be corrected for recovery using these values.

Method Blanks. Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis. A minimum of 1 method blank will be analyzed for every extraction batch or for every 20 samples (10 samples for conventional parameters), whichever is more frequent.

Sampling Documentation

Sample documentation is a critical aspect of environmental investigations. Sample possession and handling must be traceable from the time of sample collection, through laboratory and data analysis, to the time sample results are potentially introduced as evidence. A sample log form and field logbook entries will be completed for each location occupied and each sample collected. Documentation procedures for sampling are provided in greater detail in the Groundwater Sampling Operations Manual.

Sample Handling

Sample collection and handling procedures are detailed in the Groundwater Sampling Operations Manual. To control the integrity of the samples during transit to the laboratory and during hold prior to analysis, established preservation and storage measures will be taken. Table A-1-2 presents container type, preservation, and maximum holding times for various chemical analyses of groundwater. Sample containers will be labeled with the client name, survey number, sample number, sampling date and time, required analyses, and initials of the individual processing the sample. The Field QA Manager or designee will check all container labels, custody form entries, and logbook entries for completeness and accuracy at the end of each sampling day.

Sample Chain of Custody

Sample labeling and custody documentation will be performed as described in the Sampling and Analysis Plan. Custody procedures will be used for all samples at all stages in the analytical or transfer process and for all data and data documentation whether in hard copy or electronic format.

Sample Preservation

The requirements for preserving sample aliquots destined for each type of analysis for groundwater are listed in Table A-1-2. Immediately after the sample bottles are filled with groundwater they will be placed in the appropriate coolers with a sufficient number of ice packs (or crushed ice) to keep them at approximately 4 °C through the completion of that day's sampling and transport to the laboratories.

Sample Shipment

The Project QA Coordinator and Field QA Officer will be responsible for sample tracking and custody procedures in the field. The QA Coordinator will be responsible for final sample inventory and will maintain sample custody documentation. The Field QA Officer, or designee, will complete custody forms. At the end of each day, and prior to transfer, custody form entries will be made for all samples. Finally, information on the sample labels will be checked against sample logbook entries and custody forms, and samples will be recounted. All samples will be accompanied by custody forms; the forms will be signed at each point of transfer and will include sample numbers. All custody forms will be completed in indelible ink. Copies of all forms will be retained as appropriate and included as appendices to QA/QC reports to management.

Prior to shipping, sample containers will be wrapped and securely packed inside the cooler with ice packs or crushed ice by the Field QA Officer or designee. The original, signed custody forms will be transferred with the cooler. The cooler will be secured and appropriately sealed and labeled for shipping immediately. Samples will be couriered on the day of sampling.

Sample Receipt

The designated sample custodian at the laboratory will accept custody of the samples and verify that the chain of custody matches the samples received. A cooler receipt form will be filled out to document conditions of the cooler. The Project Managers at the laboratory will ensure that the custody forms are properly signed upon receipt of the samples and will note questions or observations concerning sample integrity on the custody forms. The laboratory will contact the Project QA Coordinator immediately if discrepancies are discovered between the custody forms and the sample shipment upon receipt. The laboratory Project Manager will specifically note any coolers that do not contain ice packs or are not sufficiently cold (4 ± 2 °C) upon receipt.

Data Reduction, Validation, and Reporting

All data will undergo two levels of quality assurance/quality control (QA/QC) evaluation: one at the laboratory, and one by a qualified data validator.

Data Reduction and Reporting

Initial data reduction, evaluation, and reporting at the laboratory will be carried out as described in the appropriate analytical protocols and the laboratory's QA Manual. Quality control data resulting from methods and procedures described in this document will also be reported.

The laboratory will be responsible for internal checks on data reporting and will correct errors identified during the quality assurance review. Close contact will be maintained between the Project QA Manager and the laboratory to resolve in a timely manner quality control problems that may arise. The analytical laboratory will be required, where applicable, to report the following:

- **Project Narrative.** This summary, in the form of a cover letter, will discuss problems, if any, encountered during any aspect of analysis. This summary should discuss, but not be limited to, quality control, sample shipment, sample storage, and analytical difficulties. Any problems encountered, actual or perceived, and their resolutions will be documented in as much detail as appropriate.
- **Chain of Custody Records.** Legible copies of the custody forms will be provided as part of the data package. This documentation will include the time of receipt and condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented.
- **Sample Results.** The data package will summarize the results for each sample analyzed. The summary will include the following information when applicable:
  - Field sample identification code and the corresponding laboratory identification code
  - Sample matrix
  - Date of sample extraction
  - Date and time of analysis
  - Weight and/or volume used for analysis
  - Final dilution volumes or concentration factor for the sample
  - Identification of the instrument used for analysis
  - Method reporting and quantitation limits
  - Analytical results in an EIM compatible format with reporting units identified
  - Data qualifiers and their definitions
  - A computer compact disc with the data in a format specified in advance by the Port and Occidental or their designee (consultant)
- **Quality Assurance/Quality Control Summaries.** This section will contain the results of the laboratory QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results (see above).

No recovery or blank corrections will be made by the laboratory. The required summaries are listed below; additional information may be requested.

- **Calibration Data Summary.** Report the concentrations of the initial calibration and daily calibration standards and the date and time of analysis. List the response factor, percent relative standard deviation, percent difference, and retention time for each analyte as appropriate. Report results for standards to indicate instrument sensitivity.
- **Internal Standard Area Summary.** Report the stability of internal standard areas.
- **Method Blank Analysis.** Report the method blank analyses associated with each sample and the concentration of all compounds of interest identified in these blanks.
- **Surrogate Spike Recovery.** Report all surrogate spike recovery data for organic compounds. List the name and concentration of all compounds added, percent recoveries, and range of recoveries.
- **Matrix Spike Recovery.** Report all matrix spike recovery data for organic and metal compounds. List the name and concentration of all compounds added, percent recoveries, and range of recoveries. Report the RPD for all duplicate analyses.
- **Matrix Duplicate.** Report the RPD for all matrix duplicate analyses.
- **Relative Retention Time.** Report the relative retention time of each analyte detected in the samples for both primary and conformational analyses.
- **Original Data.** Legible copies of the original data generated by the laboratory will include the following:
  - Sample refrigerator temperature log
  - Sample extraction, preparation, and cleanup logs
  - Instrument specifications and analysis logs for all instruments used on days of calibration and analysis
  - Reconstructed ion chromatograms for all samples, standards, blanks, calibrations, spikes, replicates, and reference materials
  - Enhanced spectra of detected compounds with associated best-match spectra for each sample

  - Printouts and quantitation reports for each instrument used, including reports for all samples, standards, blanks, calibrations, spikes, replicates, and reference materials
  - Original data quantification reports for each sample
  - Original data for blanks and samples not reported

Independent Data Validation and Reporting

Once data are received from the laboratory, a number of QC procedures will be followed to provide an accurate evaluation of the data quality. Specific procedures will be followed to assess data precision, accuracy, and completeness.

A data quality review will be performed by a qualified Data Validation Specialist on the data, in accordance with EPA National Functional Guidelines (EPA 2008, 2010). The data will be evaluated in accordance with the QAPP. All chemical data will be reviewed with regard to the following, as appropriate to the particular analysis.

- Chain of custody/documentation
- Holding times
- Instrument calibration
- Method blanks
- Detection limits
- Surrogate recoveries
- Matrix spike/matrix spike recoveries
- Laboratory control sample recoveries
- Laboratory and field duplicate relative percent differences

The results of the data quality review, including text assigning qualifiers in accordance with the EPA National Functional Guidelines (EPA 2008, 2010) and a tabular summary of qualifiers, will be generated by the Data Validation Specialists and submitted to the Project QA Coordinator for final review and confirmation of the validity of the data. A Quality Assurance summary of the review will be generated by the Project QA Coordinator. This summary and copies of the complete review will be presented as an appendix to the monitoring reports in EIM-compatible format.

Laboratory Audits and Corrective Actions

Laboratory and field performance audits and corrective action procedures are described in this section.

Laboratory and Field Performance Audits

Laboratory and field performance audits consist of on-site reviews of quality assurance systems and equipment for sampling, calibration, and measurement. Laboratory audits will not be conducted as part of this study; however, all laboratory audit reports will be made available to the Project QA Coordinator upon request. All laboratories are required to have written procedures addressing internal QA/QC; these procedures have been submitted and will be reviewed by the Project QA Coordinator to ensure compliance with the QAPP. All laboratories must ensure that personnel engaged in sampling and analysis tasks have appropriate training.

Laboratory will, as part of the audit process, provide for consultant's review, written details of any and all method modifications planned.

Corrective Action Procedures

Corrective Action for Field Sampling. The Field QA Officer will be responsible for correcting equipment malfunctions during the field sampling effort. The Project QA Coordinator will be responsible for resolving situations in the field that may result in noncompliance with the QAPP. All corrective measures will be immediately documented in the field logbook.

Corrective Action for Laboratory Analyses. All laboratories are required to comply with their Standard Operating Procedures. The Laboratory Project Manager will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this QAPP. All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data.

The Project QA Coordinator will be notified immediately if any quality control sample exceeds the project-specified control limits. The analyst will identify and correct the anomaly before continuing with the sample analysis. The Laboratory Project Manager will document the corrective action taken in a memorandum submitted to the Project QA Coordinator within 5 days of the initial notification. A narrative describing the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, re-extraction) will be submitted with the data package in the form of a cover letter.

References

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TABLES

Table A-1-1
Groundwater Analytes and Marine Water Quality Criteria

Analyte	State Marine Water Chronic	Analytical Method
Conventionals		
Salinity	NA	SM 2520
Total suspended solids	NA	EPA Method 160.2
Total organic carbon	NA	EPA Method 415.1
Metals in µg/L		
Antimony	NA	EPA Method 200.8
Arsenic	36	EPA Method 200.8
Beryllium	NA	EPA Method 200.8
Cadmium	9.3	EPA Method 200.8
Chromium	50	EPA Method 200.8
Copper	3.1	EPA Method 200.8
Lead	8.1	EPA Method 200.8
Mercury	0.025	EPA Method 200.8
Nickel	8.2	EPA Method 200.8
Selenium	71	EPA Method 200.8
Silver	1.9 (1)	EPA Method 200.8
Thallium	NA	EPA Method 200.8
Zinc	81	EPA Method 200.8
Semivolatile Organics in µg/L		
LPAHs		
2-Methylnaphthalene	NA	EPA Method 8270
Acenaphthene	NA	EPA Method 8270
Acenaphthylene	NA	EPA Method 8270
Anthracene	NA	EPA Method 8270
Fluorene	NA	EPA Method 8270
Naphthalene	NA	EPA Method 8270
Phenanthrene	NA	EPA Method 8270
HPAHs		
Benzo(a)anthracene	NA	EPA Method 8270
Benzo(a)pyrene	NA	EPA Method 8270
Benzo(b)fluoranthene	NA	EPA Method 8270
Benzo(k)fluoranthene	NA	EPA Method 8270
Total benzofluoranthenes	NA	EPA Method 8270
Benzo(g,h,i)perylene	NA	EPA Method 8270
Chrysene	NA	EPA Method 8270
Dibenz(a,h)anthracene	NA	EPA Method 8270
Fluoranthene	NA	EPA Method 8270
Indeno(1,2,3-c,d)pyrene	NA	EPA Method 8270
Pyrene	NA	EPA Method 8270

Table A-1-1
Groundwater Analytes and Marine Water Quality Criteria

Analyte	State Marine Water Chronic	Analytical Method
Phthalates		
Bis(2-ethylhexyl)phthalate	NA	EPA Method 8270
Butyl benzyl phthalate	NA	EPA Method 8270
Dimethyl phthalate	NA	EPA Method 8270
Diethyl phthalate	NA	EPA Method 8270
Di-n-butyl phthalate	NA	EPA Method 8270
Di-n-octyl phthalate	NA	EPA Method 8270
Phenols		
Phenol	NA	EPA Method 8270
2-Methyphenol	NA	EPA Method 8270
4-Methyphenol	NA	EPA Method 8270
2,4-Dimethylphenol	NA	EPA Method 8270
Pentachlorophenol	7.9	EPA Method 8270
Miscellaneous Extractables		
Benzyl alcohol	NA	EPA Method 8270
Benzoic acid	NA	EPA Method 8270
Dibenzofuran	NA	EPA Method 8270
N-Nitrosodiphenylamine	NA	EPA Method 8270
Volatile Organics in ug/L		
2-Butanone (MEK)	NA	EPA Method 8260
2- Chloroethyl vinyl ether	NA	EPA Method 8260
2-Hexanone (MBK)	NA	EPA Method 8260
4-Methyl-2-pentanone (MIBK)	NA	EPA Method 8260
1,1-Dichloroethane	NA	EPA Method 8260
1,1-Dichloroethene	NA	EPA Method 8260
1,1-Dichloropropene	NA	EPA Method 8260
1,2-Dichlorobenzene	NA	EPA Method 8260
1,2-Dibromoethane	NA	EPA Method 8260
1,2-Dichloroethane	NA	EPA Method 8260
cis1,2-Dichloroethene	NA	EPA Method 8260
trans1,2-Dichloroethene	NA	EPA Method 8260
1,2-Dichloropropane	NA	EPA Method 8260
1,3-Dichlorobenzene	NA	EPA Method 8260
1,3-Dichloropropane	NA	EPA Method 8260
cis 1,3-Dichloropropene	NA	EPA Method 8260
trans 1,3-Dichloropropene	NA	EPA Method 8260
1,4-Dichlorobenzene	NA	EPA Method 8260
1,4- Dichloro-2-butene	NA	EPA Method 8260
2,2-Dichloropropane	NA	EPA Method 8260
1,1,1-Trichloroethane	NA	EPA Method 8260
1,1,2-Trichloroethane	NA	EPA Method 8260

Table A-1-1
Groundwater Analytes and Marine Water Quality Criteria

Analyte	State Marine Water Chronic	Analytical Method
1,1,2-Trichloro-1,2,2-trifluoroethene	NA	EPA Method 8260
1,2,3-Trichloropropene	NA	EPA Method 8260
1,2,4-Trichlorobenzene	NA	EPA Method 8260
1,1,2,2-Tetrachloroethane	NA	EPA Method 8260
Acetone	NA	EPA Method 8260
Benzene	NA	EPA Method 8260
Bromodichloromethane	NA	EPA Method 8260
Bromoform	NA	EPA Method 8260
Bromomethane	NA	EPA Method 8260
Carbon disulfide	NA	EPA Method 8260
Carbon tetrachloride	NA	EPA Method 8260
Chlorobenzene	NA	EPA Method 8260
Chlorodibromomethane	NA	EPA Method 8260
Chloroethane	NA	EPA Method 8260
Chloroform	NA	EPA Method 8260
Chloromethane	NA	EPA Method 8260
Dibromomethane	NA	EPA Method 8260
Dibromochloromethane	NA	EPA Method 8260
Dichlorodifluoromethane	NA	EPA Method 8260
Ethyl benzene	NA	EPA Method 8260
Iodomethane	NA	EPA Method 8260
Isopropyl benzene	NA	EPA Method 8260
Methylene chloride	NA	EPA Method 8260
Styrene	NA	EPA Method 8260
Tetrachloroethene	NA	EPA Method 8260
Toluene	NA	EPA Method 8260
Trichloroethene	NA	EPA Method 8260
Trichlorofluoromethane	NA	EPA Method 8260
Vinyl acetate	NA	EPA Method 8260
Vinyl chloride	NA	EPA Method 8260
m,p- xylene	NA	EPA Method 8260
o-xylene	NA	EPA Method 8260
OC Pesticides/PCBs in ug/L		
Aldrin	0.0019	EPA Method 8081
alpha-BHC	NA	EPA Method 8081
beta-BHC	NA	EPA Method 8081
gamma-BHC	0.16 (1)	EPA Method 8081
delta-BHC	NA	EPA Method 8081
alpha-chlordane	0.004	EPA Method 8081
gamma-chlordane	0.004	EPA Method 8081
4,4'-DDD	0.001	EPA Method 8081

Table A-1-1
Groundwater Analytes and Marine Water Quality Criteria

Analyte	State Marine Water Chronic	Analytical Method
4,4'-DDE	0.001	EPA Method 8081
4,4'-DDT	0.001	EPA Method 8081
Dieldrin	0.0019	EPA Method 8081
Endosulfan I	0.0087	EPA Method 8081
Endosulfan II	0.0087	EPA Method 8081
Endosulfan sulfate	NA	EPA Method 8081
Endrin	0.0023	EPA Method 8081
Endrin aldehyde	NA	EPA Method 8081
Endrin ketone	NA	EPA Method 8081
Heptachlor	0.0036	EPA Method 8081
Heptachlor epoxide	NA	EPA Method 8081
Hexachlorobenzene	NA	EPA Method 8081
Hexachlorobutadiene	NA	EPA Method 8081
Methoxychlor	NA	EPA Method 8081
Toxaphene	0.0002	EPA Method 8081
PCBs in µg/L		
PCB-1016	0.03	EPA Method 8082
PCB-1221	0.03	EPA Method 8082
PCB-1232	0.03	EPA Method 8082
PCB-1242	0.03	EPA Method 8082
PCB-1248	0.03	EPA Method 8082
PCB-1254	0.03	EPA Method 8082
PCB-1260	0.03	EPA Method 8082
Total PCBs	0.03	EPA Method 8082

Notes:

1 = Method detection limits for groundwater quality analyses should be at or below these screening criteria if technically feasible.

µg/L = micrograms per liter

EPA = U.S. Environmental Protection Agency

HPAH = high-molecular-weight polycyclic aromatic hydrocarbon

LPAH = low-molecular-weight polycyclic aromatic hydrocarbon

NA = No criteria is defined for that chemical/parameter.

OC = organochlorine

PCB = polychlorinated biphenyl

SM = Standard Method

Table A-1-2
Data Quality Objectives for Groundwater Quality Analyses

Parameter	Precision	Accuracy	Completeness	Sample Container	Type of Container	Holding Time[a]	Preservative
Salinity	+/- 20%	+/- 20%	95%	500 mL	HPDE	28 days	cool/4 ^{o}C/dark
Total suspended solids	+/- 20%	+/- 20%	95%	500 mL	HPDE	7 days	cool/4 ^{o}C/dark
Total organic carbon	+/- 20%	+/- 20%	95%	250 mL	Amber glass	28 days	cool/4 ^{o}C/dark pH , 2, H_2SO_4
Metals	+/- 25%	+/- 25%	95%	1 L	HPDE	28 days Hg /180 days rest	cool/4 ^{o}C/dark pH < 2, HNO_3
Semivolatiles	+/- 30%	+/- 40%	95%	1 L	Amber glass	7/40 days	cool/4 ^{o}C/dark
Volatile organics	+/- 30%	+/- 30%	95%	3 x 40 mL	VOA vial	7/40 days	cool/4 ^{o}C/dark
Pesticides	+/- 30%	+/- 30%	95%	1 L	Amber glass	7/40 days	cool/4 ^{o}C/dark
PCBs	+/- 30%	+/- 30%	95%	1 L	Amber glass	7/40 days	cool/4 ^{o}C/dark

Notes:
a = When two holding times are listed, the first holding time is until extraction and the second is until analysis.
HDPE = high density polyethylene
Hg = Mercury
L = liter
mL = milliliter
PCB = polychlorinated biphenyl
VOA = volatile organic analyte

APPENDIX B
QUALITY ASSURANCE PROJECT PLAN FOR SEDIMENT QUALITY ANALYSIS

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN FOR SEDIMENT QUALITY ANALYSIS

MOUTH OF HYLEBOS WATERWAY (SEGMENTS 3, 4, AND 5)

TACOMA, WASHINGTON

Prepared for

Occidental Chemical Corporation
and
Port of Tacoma

Prepared by

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LIST OF ACRONYMS AND ABBREVIATIONS

%R	percent recovery
ARI	Analytical Resources, Inc.
ASTM	ASTM International
CCV	continuing calibration verification
cm	centimeter
COC	chain-of-custody
DDT	dichlorodiphenyl-trichloroethane
DGPS	differential global positioning system
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FC	field coordinator
GC/MS	gas chromatograph/mass spectrometer
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCB	hexachlorobenzene
HCBD	hexachlorobutadiene
ID	identification
LCS	laboratory control sample
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
NAD 83	North American Datum of 1983
NCD	nearshore confined disposal
Occidental	Occidental Chemical Corporation
OMMP	Operations, Maintenance, and Monitoring Plan
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PAHs	polynuclear aromatic hydrocarbons
Port	Port of Tacoma
PQL	practical quantitation limits
PRDE	Pre-Remedial Design Evaluation

PSEP	Puget Sound Estuary Program
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RACR	Remedial Action Construction Report
RD	remedial design
RL	reporting limit
ROD	Record of Decision
RPD	relative percent difference
SQOs	sediment quality objectives
SOW	Statement of Work
SRAL	sediment remedial action level
SRM	standard reference material
TOC	total organic carbon
TPU	Tacoma Public Utilities

1 INTRODUCTION

This Quality Assurance Project Plan (QAPP) for Sediment Quality Analysis has been prepared as a component (Appendix B) of the Operations, Maintenance, and Monitoring Plan (OMMP; Anchor QEA 2015), which presents the post-remedial action sediment monitoring activities that will be performed as part of the Mouth of Hylebos Waterway Cleanup Project in Tacoma, Washington (Figure 1). The overall objective of the monitoring program is to confirm that remedial actions performed at the site achieve performance standards specified in the Commencement Bay Nearshore/Tideflats Record of Decision (ROD; EPA 1989) and the Hylebos Cleanup/Slip 1 Nearshore Confined Disposal (NCD) Facility Project Statement of Work (SOW; Hylebos Waterway Cleanup Project SOW, Appendix A of the 2005 Consent Decree). This QAPP describes activities to be conducted to achieve the OMMP sediment monitoring objectives. An additional QAPP addressing groundwater is included as Appendix A, Attachment A-1, of the OMMP.

This QAPP identifies the purpose and objectives of the data collection, presents the sampling designs to achieve each objective, and specifies field and quality assurance/quality control (QA/QC) procedures to be implemented during field sampling activities and laboratory analyses. This QAPP has been developed in accordance with the Washington State Department of Ecology (Ecology) Sediment Sampling and Analysis Plan Appendix (2008), and U.S. Environmental Protection Agency (EPA) and Ecology QAPP guidelines (EPA 2002 and Ecology 2004). Analytical methods and QA/QC procedures were also developed based on the analytical protocols and quality assurance guidance of the Puget Sound Estuary Program (PSEP 1986, 1997a, 1997b), EPA's Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods (EPA 2015), and the *EPA Contract Laboratory Program National Functional Guidelines for Data Review* (EPA 2008).

This QAPP is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Project Management and Responsibilities
- Section 3 – Surface Sediment Sample Design
- Section 4 – Sample Collection, Processing, and Handling Procedures
- Section 5 – Sample Transport and Chain-of-Custody Procedures

- Section 6 – Chemical and Physical Analytical Testing
- Section 7 – Quality Assurance Project Plan
- Section 8 – Data Summary Report
- Section 9 – References

1.1 Project Description/Background

The overall objectives of the monitoring programs described in the OMMP are to determine if remedial actions at the site have achieved performance standards specified in the Commencement Bay Nearshore/Tideflats ROD (EPA 1989) and the Hylebos Cleanup/Slip 1 NCD Facility Project SOW (Hylebos Waterway Cleanup Project SOW) specified in the Consent Decree (Civil Action No. C05-5105 FDB). The three sediment monitoring objectives described in the OMMP (Anchor QEA 2015) are presented below:

1. Verify that surface sediment concentrations in Segments 3 to 5 natural recovery areas, including prior dredging areas with remaining post-dredge residuals, recover to sediment quality objectives (SQOs) within the time frame established by EPA in the ROD and SOW.
2. Confirm the containment and protectiveness of subsurface contaminated sediment deposits.
3. Evaluate the overall effectiveness of ongoing source control actions as measured by sediment quality over time and support comparisons with surface sediment verification data collected separately in Segments 1 and 2 that appear to show a recent increasing trend in polychlorinated biphenyl (PCB) concentrations within parts of the Hylebos Waterway (DOF 2012).

To achieve these objectives, the following three types of sediment monitoring are described in the OMMP and this QAPP:

1. Natural recovery monitoring
2. Sediment stability and protectiveness monitoring
3. Source control monitoring

1.1.1 Natural Recovery Monitoring

Surface sediments will be monitored in the natural recovery areas to verify the effectiveness of natural recovery in reducing concentrations of chemicals of concern over time.

1.1.1.1 Location-specific Sediment Remedial Action Levels

As defined in the ROD and Hylebos Waterway Cleanup Project SOW, the sediment remedial action level (SRAL) for a given chemical is the sediment concentration predicted to decrease to the SQO within a 10-year natural recovery period. Numerical SRALs vary by location within the Hylebos Waterway, largely because of varying sedimentation rates. SRALs for the project area were developed in the Hylebos Waterway Pre-Remedial Design Evaluation (PRDE) report approved by EPA (HCC 1999), and represent conservative estimates of the natural recovery potential at different locations within the waterway. The point of compliance for achieving SQOs is defined in the ROD as the top 10 centimeters (cm) of sediment.

1.1.1.2 Surface Sediment Natural Recovery Monitoring

Surface sediments will be sampled within designated natural recovery areas to confirm predictions of natural recovery over the next 10 years. As defined in the SOW, the 10-year natural recovery timeframe will begin upon EPA's approval of the Remedial Action Construction Reports (RACRs) (Occidental and Port 2014a and 2014b). Natural recovery monitoring within the Mouth of Hylebos Waterway will be performed at sampling locations that exceeded SQO chemical criteria during the most recent sampling but were nevertheless below the location-specific SRAL performance standard. Natural recovery monitoring will be performed in Segments 3 to 5, within designated natural recovery areas (Hart Crowser et al. 2003), and at one location in Segment 1.

Natural recovery monitoring sampling also will be conducted to verify anticipated recovery to SQO chemical criteria in Segment 3 to 5 dredging areas where post-dredge residual sediment concentrations exceeded one or more SQO chemical criteria at the completion of remedial dredging but were nevertheless below the location-specific SRAL dredging performance standards.

1.1.2 Sediment Stability and Protectiveness Monitoring

In addition to the surface sediment natural recovery monitoring described above, the SOW also requires confirmation of the continued containment and protectiveness of subsurface contaminated sediment deposits. As discussed in the final design documents and RACRs (Occidental and Port 2014a and 2014b), subsurface contaminated sediment deposits overlain with surface sediments below SQO chemical criteria are located in portions of Segments 3 and 4. The OMMP requires sediment stability sampling to ensure the continued protectiveness of these areas.

1.1.3 Source Control

As discussed in Section 1.1 of the OMMP and consistent with the SOW, a secondary objective of the OMMP is to evaluate the overall effectiveness of source control actions in the Hylebos Waterway as measured by sediment quality over time and to support comparisons with surface sediment verification data collected separately in Segments 1 and 2 that appear to show a recent increasing trend in PCB concentrations (DOF 2012). To support this objective, all OMMP surface sediment samples will be analyzed for grain size, total organic carbon (TOC), and PCBs (Aroclor method). In addition, surface sediment samples collected from twelve representative stations will be analyzed for the full list of Mouth of Hylebos Waterway chemicals of concern.

1.2 Field Investigation Project Schedule

Sediment sampling under this OMMP is currently targeted to be initiated within 60 days of receipt of EPA's written approval of the OMMP. A data validation and brief data summary report will be provided to EPA within 60 days of the receipt of final validated data.

2 PROJECT MANAGEMENT AND RESPONSIBILITIES

This section describes the overall project management strategy for implementing the QAPP. The project will be executed by consultants specializing in sediment and groundwater work. Consultant selection for this project may be subject to the Port of Tacoma's (Port's) procurement process. Key individuals will be named at least 30 days prior to commencement of field work and will be subject to approval by EPA. The laboratory, Analytical Resources, Inc. (ARI), is named to ensure laboratory consistency between this and former sediment sampling events.

2.1 Project Planning and Coordination

The project manager is responsible for developing and completing the QAPP. Following QAPP approval by EPA, the project manager will be responsible for administrative coordination to ensure the timely and successful completion of the sampling, analyses, and reporting. On behalf of Occidental Chemical Corporation (Occidental) and the Port, the project manager will provide a copy of the approved QAPP to the sampling and testing subcontractors. The project manager will discuss and coordinate any significant deviations from the approved QAPP with the EPA, Occidental, and the Port.

The project manager will be responsible for preparation of the Data Report that will summarize the sampling effort, analytical methods, QA/QC narrative, and analytical results. The content of the Data Summary Report is further described in Section 8 of this QAPP.

2.2 Field Sample Collection

The field coordinator (FC) will provide overall direction to the field sampling in logistics, personnel assignments, and field operations. The FC will supervise field collection of the surface sediments and will be responsible for ensuring accurate positioning and recording of sample locations, depths, and identification (ID); ensuring conformity to sampling and handling requirements, including field decontamination procedures; physical evaluation and documentation of the samples; and delivery of the samples to the laboratory.

The FC will ensure that sediment and water samples are stored under proper conditions in their custody until delivery to the laboratory. The FC will be responsible for summarizing field sampling activities. This summary will include details of the sampling effort, sample preparation, sample storage and transport procedures, and field quality assurance, and the summary will document any deviation from the QAPP.

The sampling and analysis will be completed with equipment owned or rented by the consultant. All subconsultants will follow the protocols established in this QAPP.

2.3 Laboratory Preparation and Analyses

Cheronne Oreiro of ARI, Tukwila, Washington, will be responsible for physical and chemical analyses. Ms. Oreiro will ensure that the submitted samples are handled and analyzed in accordance with the Puget Sound Estuary Program (PSEP) analytical testing protocols, QA/QC requirements, and the requirements specified in this QAPP (Section 7). ARI will provide certified, pre-cleaned sample containers and will prepare a data package containing all analytical and QA/QC results.

2.4 Quality Assurance/Quality Control Management

The QA/QC manager will be responsible for all coordination with the analytical laboratory and will perform oversight for both the field sampling and laboratory programs. The QA/QC manager will be kept fully informed of field program procedures and progress during sample collection and laboratory activities during sample preparation. They will record and correct any activities that vary from this QAPP. Upon completion of the sampling and analytical program, the QA/QC manager will review laboratory QA/QC results and incorporate findings into the Data Validation Report. Any QA/QC problems will be brought to the attention of EPA as soon as possible to discuss issues related to the problem and to evaluate potential solutions.

2.5 Special Training Requirements/Certifications

For sample collection and preparation tasks, it is important that field crews are trained in standardized data collection requirements so that the data collected are consistent among the field crew. All field crew will be fully trained in the collection and processing of surface sediment grab sampling, decontamination protocols, and chain-of-custody (COC) procedures.

In addition, the 29 Code of Federal Regulations 1910.120 Occupational Safety and Health Administration (OSHA) regulations require training to provide employees with the knowledge and skills enabling them to perform their jobs safely and with minimum risk to their personal health. All sampling personnel will have completed the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training course and 8-hour refresher courses, as necessary, to meet the OSHA regulations.

3 SURFACE SEDIMENT SAMPLE DESIGN

As described in Section 1, the primary focus of this investigation is to collect surface sediment quality data from natural recovery areas to determine the effectiveness of natural recovery in reducing concentrations of chemicals of concern in surface sediments. Additionally, concurrent surface sediment sampling will be conducted to evaluate the recontamination of sediment in “no-action” areas.

The methods and procedures for the collection of field samples, rationale for the sampling design, and design assumptions for locating and selecting environmental samples are detailed in the following sections. All sampling procedures will comply with EPA and Ecology protocols. The chemical and physical analytical testing methods, SQOs, and practical quantitation limits (PQLs) are presented in Table 1. All sediment samples will be analyzed for the full suite of Mouth of Hylebos contaminants of concern.

For consistency, the disparate historical sediment location nomenclature have been replaced with the study purpose prefix (OMMP) and numeric identifier (1 through 40) as detailed in the OMMP. For example, historical station HY-321-1 has been revised to station OMMP-36. The new and historical station identification are listed in Table 2. The sediment sampling locations are shown in Figure 2.

3.1 Natural Recovery Monitoring

Natural recovery monitoring locations and analysis are summarized on Table 2 and depicted in Figure 2. Sampling locations with PRDE and/or post-dredge verification stations will be re-occupied to allow for an accurate assessment of natural recovery. The natural recovery monitoring will include analysis for all Mouth of the Hylebos chemicals of concerns, some of which were present above SQOs during the most recent sampling, as summarized below.

Natural recovery monitoring will be performed within designated natural recovery areas in Segments 3 to 5 (Hart Crowser et al. 2003) and Segment 1:

- **Chinook Marina** (represented by Stations OMMP-8, OMMP-9, OMMP-11, OMMP-13, OMMP-14, and OMMP-15), which exceeded SQO chemical criteria for cadmium, copper, hexachlorobenzene (HCB), and/or hexachlorobutadiene (HCBD) during remedial design (RD)

- **Navy Bank Nearshore** (represented by Stations OMMP-19 and OMMP-20), which exceeded SQO chemical criteria for polynuclear aromatic hydrocarbons (PAHs) and/or dichlorodiphenyl-trichloroethane (DDT) breakdown products during RD
- **Tacoma Public Utilities** (TPU) Nearshore (Station OMMP-24), which exceeded SQO chemical criteria for PAHs and/or PCBs during RD
- **Simons Nearshore** (SMA 401; represented by Station OMMP-31), which exceeded SQO chemical criteria for PCBs and phthalates during RD
- **Buffelen Embankment** (SMA 341; represented by Station OMMP-34), exceeded SQO chemical criteria for PAHs and PCBs during RD
- **Murray-Pacific Channel** (represented by Station OMMP-37), in the vicinity of an existing sanitary sewer line, which exceeded the SQO chemical criterion for PCBs during RD
- **Wasser Winters Nearshore** (SMA 103; represented by OMMP-40) in Segment 1, which exceeded SQO chemical criteria for DDT breakdown products during RD; this area is also of potential concern with respect to possible metals, PAHs, and PCB releases.

Natural recovery monitoring sampling also will be conducted in Segments 3 to 5 dredging areas where post-dredge residual sediment concentrations exceeded one or more SQO chemical criteria at the completion of remedial dredging, but were nevertheless below the location-specific SRAL dredging performance standards. Confirmatory post-dredge natural recovery monitoring will be performed in these areas to verify anticipated recovery of SQO chemical criteria. The areas and natural recovery chemicals that will be analyzed include the following:

- **Segment 5 Channel**, re-occupying those post-dredge verification sampling stations that had residual concentrations exceeding SQO chemical criteria for HCBD (Stations OMMP-3 through OMMP-7, OMMP-10, OMMP-12, OMMP-16 through OMMP-18, and OMMP-21); Station OMMP-22located near the Segment 4/5 boundary exceeded SQO chemical criteria for PCBs

- **American Nearshore** (SMA 421B), re-occupying those post-dredge verification sampling stations that had residual concentrations exceeding SQO chemical criteria for one or more PAHs (Stations OMMP-26 through OMMP-28)
- **Sound Refining Shoaling Area** (SMA S44) re-occupying those post dredge verification stations where PCBs and/or arsenic concentrations were greater than the SQO (Stations OMMP-33 and OMMP-35)

3.2 Sediment Stability and Protectiveness Monitoring

Sediment stability and protectiveness monitoring station locations are shown in Figure 2 and Table 2. These stations are located in subsurface contaminated sediment deposit areas of Segments 4 and 3.

- **Tacoma Public Utilities** (SMA 402, Station OMMP-24)
- **Simons Channel** (SMA 401A; Stations OMMP-29, OMMP-30, and OMMP-32)
- **Murray-Pacific Channel** (SMA 322 and adjacent areas; Stations OMMP-36, OMMP-38, and OMMP-39)

All OMMP surface sediment samples collected from these stations will be analyzed for grain size, TOC, and PCBs (Aroclor method).

3.3 Source Control Monitoring

A secondary objective of this OMMP is to evaluate the overall effectiveness of source control actions in the Hylebos Waterway as measured by sediment quality over time, and to support comparisons with surface sediment verification data collected separately in Segments 1 and 2 that appear to show a recent increasing trend in PCB concentrations (DOF 2012). To support this objective, all OMMP surface sediment samples will be analyzed for the full list of Mouth of Hylebos Waterway chemicals of concern:

- OMMP-1
- OMMP-2
- OMMP-3
- OMMP-10
- OMMP-22

- OMMP-23
- OMMP-25
- OMMP-33
- OMMP-35
- OMMP-36
- OMMP-38
- OMMP-39

When combined with other coordinated long-term monitoring programs, the aggregate long-term monitoring data are anticipated to be sufficient to evaluate the overall effectiveness of source control actions in the Hylebos Waterway.

4 SAMPLE COLLECTION, PROCESSING, AND HANDLING PROCEDURES

Sample collection process and handling procedures are described in this section, which are consistent with sampling, analysis, and data validation procedures used during the previous post-dredge sampling efforts (Anchor 2003). The point of compliance for achieving SQOs is defined in the Commencement Bay Nearshore/Tideflats ROD as the top 10 cm of sediment. Sufficient time may not have elapsed since the 2003/2004 dredging actions to allow 10 cm of new sediment to deposit in the dredge areas. For example, during the February 2012 sediment sampling performed in Segments 1 and 2 (DOF 2012), the top 10 cm of some of the surface sediment samples collected in that area of the Hylebos Waterway were comprised of less than 10 cm of recently deposited silt materials overlying native sand deposits. To evaluate if surface sediment samples collected for the Segments 3 to 5 OMMP are representative of recent (e.g., post-dredge) depositional materials, the lithology of the surface sediment layers will initially be logged in the field. Regardless of the lithology observed, a Single 0- to 10-cm sample will be collected each station.

4.1 Station and Sample Identification and Nomenclature

Each sample will be assigned a unique alphanumeric identifier according to the following method:

- Each sample ID will be identified by *Location ID-Date*
    - The Location ID is based is OMMP followed by an assigned numeric value (1 through 40)
    - Individual sediment samples at each location will be identified by the Location ID and the six digit date code YYMMDD format (e.g., OMMP-1-160111 from location HY-512 on January 11, 2016).
- A field duplicate collected from a sample will be identified by a fictitious Sample ID starting with AQ followed by a number given in sequential order starting with 100. The actual sample location will be recorded in the field notes but will not be identified to the analytical laboratory. A duplicate sample of the above sediment grab example would be AQ-101-160111.

4.2 Station Positioning

Horizontal positioning will be determined by the onboard differential global positioning system (DGPS) based on target coordinates shown in Table 2. Measured station positions will be converted to latitudinal and longitudinal coordinates to the nearest 0.01 second. The accuracy of measured and recorded horizontal coordinates is typically less than 1 meter and will be within 2 meters according to PSEP guidance. Northing and easting coordinates of the vessel will be updated every second and displayed directly on a computer onboard the vessel. The coordinates will then be processed in real time and stored at the time of sampling using the DGPS software package. Washington State Plane Coordinates, North, North American Datum of 1983 (NAD 83) will be used for the horizontal datum.

The vertical elevation of each station will be measured using a fathometer or lead line. This depth will be corrected for tidal influence after sampling has been completed to obtain the depth of the mudline relative to mean lower low water. Tidal elevation will be determined by calling the National Ocean Service for data from its automated Tide Gage 9446484 located in Tacoma, Washington.

A checkpoint will be located at a known point that is accessible by the sampling vessel (such as a pier face, dock, piling, or similar structure) to ensure the accuracy of the navigation system. At the beginning and end of each day, the vessel will be stationed at the check point, a DGPS reading will be taken, and the two readings will be compared. The two position readings should agree, within the limits of survey vessel operational mobility, to within 1 to 2 meters.

4.3 Surface Sediment Collection Methods

The sample design is presented in Table 2 and includes location ID, coordinates, analyses, and sample purpose (i.e., monitored natural recovery, sediment stability and protectiveness, and/or source control evaluation).

4.3.1.1 Sampling Platform

Surface sediment will be collected from a vessel specifically designed to support environmental sampling activities by a qualified operator. The vessel will be equipped with a DGPS, an A-frame and winch, seawater pumps, and a depth sounder. Surface sediment samples will be collected with a modified van Veen sampler (e.g., power grab).

4.3.1.2 Surface Sediment Sample Collection and Processing

Surface sediment samples for laboratory analyses from the 0- to 10-cm will be collected for physical and chemical using a van Veen grab sampler in accordance with PSEP and Ecology guidelines (PSEP 1997a and Ecology 2008). The van Veen grab sampler is used to collect sufficient volume, surficial sediment samples. The sampler utilizes a hinged jaw assembly for sample collection. Upon contact with sediments, the jaws are drawn shut to collect the sample. The grab sampler will be used to collect samples in the following manner:

- Vessel will maneuver to proposed location.
- Jaw assembly will be decontaminated and deployed.
- The winch cable to the grab sampler will be drawn taut and vertical.
- Location of the cable hoist will be measured and recorded by the location control personnel.
- The jaw assembly will be closed to collect the sediment sample to a penetration depth of approximately 20 cm.
- The sediment sample will be retrieved aboard the vessel and evaluated against the following PSEP acceptability criteria:
    - Grab sampler is not overfilled (i.e., sediment surface is not against the top of sampler)
    - Sediment surface is relatively flat, indicating minimal disturbance or winnowing (for the wood debris characterization samples, acceptable grab samples will allow for minor surface disturbance)
    - Overlying water is present, indicating minimal leakage
    - Overlying water has low turbidity, indicating minimal sample disturbance
    - Desired penetration depth is achieved
- Overlying water will be siphoned off and a small core tube will be inserted within the grab. A stainless steel spoon will be used to collect a 0- to 10-cm sediment layer from inside the sampler around the core tube from which the lithology of the surface sediment layer be logged in the field. A single 0- to 10-cm composite sample will be processed for the location.

- Sediment will be collected from the appropriate layer taking care not to collect sediment in contact with the sides of the sampler.
- The collected sediment will be placed in a stainless steel mixing bowl. When sufficient sample volume has been collected, the sediment will be homogenized using a stainless steel spoon.
- Homogenized sediment will be placed immediately into appropriate pre-labeled sample containers (Table 3) and placed immediately stored on ice and maintained at 4 degrees Celsius (°C) until delivered to the laboratory.

Collection form and Daily Log notes of all grab samples will be maintained as samples are collected and correlated to the sampling location map. The following information will be included the Sample Collection Form or Daily Log:

- Water depth to mudline surface
- Location of each grab sample as determined by DGPS
- Date and time of collection of each sediment grab sample
- Names of field supervisor and person(s) collecting and logging the sample
- Observations made during sample collection including weather conditions, complications, ship traffic, and other details associated with the sampling effort
- Location and Sample ID
- Presence of depositional material and thickness
- Physical soil description in accordance with ASTM International (ASTM) procedures (ASTM D2488 [2005] and ASTM D2487 [2006] – Unified Soil Classification System) including soil type, density/consistency of soil, and color
- Odor (e.g., hydrogen sulfide, petroleum)
- Vegetation and debris (e.g., wood chips or fibers, paint chips, concrete, sand blast grit, and metal debris)
- Biological activity (e.g., detritus, shells, tubes, bioturbation, and live or dead organisms)
- Presence of oil sheen
- Any other distinguishing characteristics or features
- Any deviation from the approved sampling plan

4.3.2 *Sample Handling Procedures*

Filled sample containers will be stored in coolers containing ice to maintain the samples at 4° ±2°C until delivery to the analytical laboratory.

All working surfaces and instruments will be thoroughly cleaned, decontaminated, and covered with aluminum foil to minimize outside contamination between sampling events. Disposable gloves will be discarded after processing each surface sediment sample and replaced prior to handling decontaminated instruments or work surfaces.

Sample containers will be kept in packaging as received from the analytical laboratory until use; a sample container will be withdrawn only when a sample is to be collected and will be returned to a cooler containing completed samples.

4.4 Field Quality Assurance Samples

Field QA samples will be collected along with the environmental samples to identify possible problems resulting from sample collection or sample processing in the field. The collection of field QA samples includes homogenized field duplicates and matrix spike/matrix spike duplicates (MS/MSDs) as described below. All field QA samples will be documented in the field logbook and verified by the QA/QC Coordinator or designee.

Field precision will be evaluated by the collection of blind field duplicates at a frequency of 20 percent. Field duplicate samples will be prepared by homogenizing sufficient sample volume from a location. The field duplicate will be labeled with a fictitious sample location name and will be analyzed for the same constituent list as the original sample. Field duplicate precision will be screened against a relative percent difference (RPD) of 50 percent for sediment samples. However, no data will be qualified based solely on field duplicate precision.

Additional MS/MSD sample volume will be collected to ensure that the laboratory has sufficient sample volume to run the program-required analytical QA/QC samples for analysis. MS/MSD samples will be collected at a frequency of one per sampling event or one in 20 samples processed, whichever is more frequent. MS/MSD samples will be identified as such on sample labels and the COC form, and will retain the same sample identifier as the original sample.

4.5 Sample Containers

The analytical lab will provide certified, pre-cleaned, EPA approved containers for all samples (Table 3).

4.6 Sample Identification and Labels

Each sample will have an adhesive plastic or waterproof paper label affixed to the container and will be labeled at the time of collection. The following information will be recorded on the container label at the time of collection:

- Project name
- Sample ID
- Date and time of sample collection
- Preservative type (if applicable)

Samples will be uniquely identified with a sample ID that at a minimum specifies sample matrix, sample number, sample location, and type of sample.

4.7 Field Equipment

The following items will be needed in the field for sediment collection:

- QAPP
- Surface Sediment Collection and Daily Log Forms
- Site map
- Cellular phone
- Digital camera
- DGPS
- Stainless-steel bowls and spoons
- Tape measure
- Lead line
- Alconox detergent
- Scrub brushes
- Distilled water
- Spray bottles for distilled water
- Coolers
- Powder-free exam gloves
- Steel toed rubber boots
- Duct tape
- Ziploc bags
- Aluminum foil

- Paper towels
- First aid kit
- Grab sampler
- Wet ice
- Personal flotation devices
- Hard hats
- Safety glasses
- Foul weather gear
- Waterproof labels
- Clear packing tape
- Box cutters
- Bubble wrap
- COC forms
- Sample jars
- Custody seals

Prior to mobilization, these lists will be consulted to ensure all equipment is available and pre-cleaned. As part of the mobilization process, each item will be double-checked by the FC.

4.8 Equipment Decontamination Procedures

Sample containers, instruments, working surfaces, technician protective gear, and other items that may come into contact with sediment must meet high standards of cleanliness. All equipment and instruments used that are in direct contact with the sediment collected for analysis will be made of glass, stainless steel, or high density polyethylene, and will be cleaned prior to each day's use and between sampling or compositing events. Decontamination of all items will follow PSEP protocols. The decontamination procedure is as follows:

- Perform pre-wash rinse with site water
- Wash with solution of laboratory-grade, non-phosphate-based soap (e.g., Alconox®)
- Rinse with site water
- Rinse three times with laboratory-grade distilled water
- Cover all decontaminated items with aluminum foil
- Store in clean area or closed container for next use

4.9 Field Generated Waste Management

All sediment remaining after sampling will be washed overboard at the collection site prior to moving to the next sampling station. Any sediment spilled on the deck of the sampling vessel will be washed into the surface waters at the collection site.

All disposable sampling materials and personnel protective equipment used in sample processing, such as disposable coveralls, gloves, and paper towels, will be placed in heavy-duty garbage bags for disposal.

5 SAMPLE TRANSPORT AND CHAIN-OF-CUSTODY PROCEDURES

This section addresses the sampling program requirements for maintaining custody of the samples throughout the sample collection and delivery process.

5.1 Sample Custody Procedures

Samples are considered to be in one's custody if they are in the custodian's possession or view, in a secured location (under lock) with restricted access, or in a container that is secured with an official seal such that the sample cannot be reached without breaking the seal.

COC procedures will be followed for all samples throughout the collection, handling, and analysis process. The principal document used to track possession and transfer of samples is the COC form. Each sample will be represented on a COC form the day it is collected. All data entries will be made using indelible ink pen. Corrections will be made by drawing a single line through the error, writing in the correct information, then dating and initialing the change. Blank lines or spaces on the COC form will be lined-out and dated and initialed by the individual maintaining custody.

A COC form will accompany each cooler of samples to the analytical laboratory. Each person who has custody of the samples will sign the COC form and ensure that the samples are not left unattended unless properly secured. Copies of all COC forms will be retained in the project files.

5.2 Sample Delivery and Receipt Requirements

All samples will be hand delivered to the analytical laboratory no later than the day after collection. The persons transferring custody of the sample container will sign the COC form upon transfer of sample possession to the analytical laboratory. When the samples are delivered to the laboratory, the receiver will record the condition of the samples on a sample receipt form. COC forms will be used internally in the laboratory to track sample handling and final disposition.

6 CHEMICAL AND PHYSICAL ANALYTICAL TESTING

Sediment samples will be submitted for chemical and physical analyses as presented on Table 2. All sediment samples selected for testing will be analyzed for grain size, TOC, and PCBs. A subset of samples will be analyzed for additional chemical(s) of interest as discussed in Section 3.1. Table 1 provides the analyte list and the target laboratory reporting limit (RL) for each analyte for sediment.

Method detection limits (MDLs) will be below the RLs specified in Table 1, if technically feasible. To achieve the required RLs, some modifications to the methods may be necessary. These modifications from the specified analytical methods will be provided by the laboratory at the time of establishing the laboratory contract.

Chemical and physical testing will be conducted at ARI, which is accredited by the National Environmental Laboratories Accreditation Program and Ecology. All chemical and physical testing will adhere to the most recent PSEP analysis protocols and QA/QC procedures (PSEP 1986, 1997b, 1997c). If more current analytical methods are available, the laboratory will use them.

In completing chemical analyses for this project, the contract laboratory is expected to meet the following minimum requirements:

- Adhere to the methods outlined in this QAPP, including methods referenced for each analytical procedure (Table 1)
- Deliver hard copy and electronic data as specified
- Meet reporting requirements for deliverables
- Meet turnaround times for deliverables
- Implement QA/QC procedures including data quality objectives (DQOs), laboratory quality control requirements, and performance evaluation testing requirements (Tables 4 and 5)
- Notify the project QA/QC Manager of any QA/QC problems when they are identified to allow for quick resolution
- Allow laboratory and data audits to be performed, if deemed necessary

Laboratory QC procedures, where applicable, include initial and continuing instrument calibration verifications, standard reference materials (SRMs), laboratory control samples (LCS), matrix replicates, matrix spikes, surrogate spikes (for organic analyses), and method blanks. Table 5 lists the frequency of analysis for laboratory QC samples and Table 4 summarizes the DQOs for precision, accuracy, and completeness.

Results of the QC samples from each sample group will be reviewed by the analyst immediately after a sample group has been analyzed. All samples are diluted and reanalyzed if target compounds are detected at levels that exceed their respective established calibration ranges. Any cleanups will be conducted prior to the dilutions. The QC sample results will be evaluated to determine if control limits have been exceeded. If control limits are exceeded in the sample group, the QA/QC Manager will be contacted immediately, and corrective action (e.g., method modifications followed by reprocessing the affected samples) will be initiated prior to processing a subsequent group of samples.

7 QUALITY ASSURANCE PROJECT PLAN

This section establishes QA objectives and functional activities associated with the sediment sampling. The methods and QA procedures described in this QAPP will be followed during various data collection activities.

The goal of this QAPP is to ensure that data of sufficiently high quality are generated to support the DQOs. This section describes analytical QA/QC procedures, assessment and oversight, and data reduction, validation, and reporting. This QAPP was prepared following Ecology's and EPA's QAPP guidance documents (Ecology 2008 and EPA 2002). Analytical QA/QC procedures were also developed based on the analytical protocols and quality assurance guidance of the PSEP (PSEP 1986, 1997b, and 1997c). The recommended quality control limits for conventional parameters, organic chemicals, and metals are presented in Table 5.

Field and laboratory activities must be conducted in such a manner that the results meet specified quality objectives and are fully defensible. Guidance for QA/QC is derived from the protocols developed for PSEP (PSEP 1986, 1997b, and 1997c) and EPA SW-846, the USEPA Contract Laboratory Program (EPA 2004, 2008).

7.1 Laboratory Quality Control

Laboratory QC procedures, where applicable, include initial and continuing instrument calibration verifications, SRMs, LCSs, matrix replicates, MS, surrogate spikes (for organic analyses), and method blanks. Results of the QC samples from each sample group will be reviewed by the analyst immediately after a sample group has been analyzed. The QC sample results will then be evaluated to determine if control limits have been exceeded. If control limits are exceeded in the sample group, the QA/QC Manager will be contacted immediately, and corrective action (e.g., method modifications followed by reprocessing the affected samples) will be initiated prior to processing a subsequent group of samples.

7.1.1 Laboratory Instrument Calibration and Frequency

An initial calibration will be performed on each laboratory instrument to be used prior to the start of the project, after each major interruption to the analytical instrument, and when any ongoing calibration does not meet method control criteria. Calibration verification will be analyzed following each initial calibration and will meet method criteria prior to analysis of samples. Continuing calibration verifications (CCV) will be performed daily prior to any sample analysis to track instrument performance. The frequency of CCVs varies with method. For gas chromatograph/mass spectrometer (GC/MS) methods, one CCV will be analyzed every 12 hours. For GC/MS, metals, and inorganic methods, one CCV will be analyzed for every ten field samples, or daily, whichever is specified in the method. If the ongoing continuing calibration is out of control, the analysis must come to a halt until the source of the control failure is eliminated or reduced to meet control specifications. All project samples analyzed while instrument calibration was out of control will be reanalyzed.

Instrument blanks or continuing calibration blanks provide information on the stability of the baseline established. Continuing calibration blanks will be analyzed immediately prior to, or immediately following, CCV at the instrument for each type of applicable analysis.

7.1.2 Laboratory Duplicates and Replicates

Analytical duplicates provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Analytical duplicates and replicates are subsamples of the original sample that are prepared and analyzed as a separate sample.

7.1.3 Matrix Spikes/Matrix Spike Duplicates

Analysis of MS samples provides information on the extraction efficiency of the method on the sample matrix. By performing duplicate MS analyses, information on the precision of the method is also provided for organic analyses.

7.1.4 Method Blanks

Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis. The method blank for all analyses must be less than the MRL of any single target analyte or compound. If a laboratory method blank exceeds this criterion for any analyte or compound, and the concentration of the analyte or compound in any of the samples is less than five times the concentration found in the blank (ten times for common contaminants), analyses must stop and the source of contamination must be eliminated or reduced.

7.1.5 Laboratory Control Samples

LCS are analyzed to assess possible laboratory bias at all stages of sample preparation and analysis. The LCS is a matrix-dependent spiked sample prepared at the time of sample extraction along with the preparation of sample and the MS. The LCS will provide information on the precision of the analytical process, and when analyzed in duplicate, will provide accuracy information as well.

7.1.6 Standard Reference Materials

SRMs are analyzed to assess possible matrix affects at all stages of sample preparation and analysis. The SRM is a matrix-matched sample that is carried through all aspects of preparation and analysis as a field sample and has a known concentration of target analytes. Performance will be evaluated using the DQOs listed in Table 4 and as outlined in Ecology (2008) and EPA (2002).

7.2 Laboratory Data Package

ARI will prepare a detailed laboratory data package documenting all activities associated with the sample analyses. The following information will be included in this data package:

- **Project Narrative:** A detailed narrative that describes the samples received, analyses performed, and corrective actions undertaken.
- **COC Documentation:** Laboratory policy requires that COC documentation be available for all samples received. The COC will document basic sample demographics such as client and project names, sample ID, analyses requested, and special instructions.
- **Data Summary Form:** A tabular listing of concentrations or detection limits for all target analytes. The data summary form will also list other pertinent information such as amount of sample analyzed, dilution factors, sample processing dates, extract cleanups, and surrogate recoveries.

- **QC Summary:** Includes results of all QC analyses, specifically recovery information. LCSs are reported with each batch. Additional QC analyses may include laboratory replicates, MS/MSDs, and SRMs.
- **Instrument Calibration Forms and Raw Data:** Includes initial and continuing calibration summaries and instrument tuning data, laboratory bench sheets, and logbook pages.

Additional laboratory deliverables will be required including instrumental output files for the ID and quantitation of target analytes in calibration and sample runs, and instrument binary files for all analyses.

7.3 Data Quality Objectives and Criteria

The DQO for this project is to ensure that the data collected are of known and acceptable quality so that the project objectives described above can be achieved. The quality of the laboratory data is assessed by precision, accuracy, representativeness, comparability, and completeness parameters. Definitions of these parameters and the applicable QC procedures are given below. Applicable quantitative goals for these data quality parameters are listed or referenced below.

7.3.1 Precision

Precision is the ability of an analytical method or instrument to reproduce its own measurement. It is a measure of the variability, or random error, in sampling, sample handling, and laboratory analysis. ASTM (2002) recognizes two levels of precision:

- Repeatability – The random error associated with measurements made by a single test operator on identical aliquots of test material in a given laboratory, with the same apparatus, under constant operating conditions
- Reproducibility – The random error associated with measurements made by different test operators, in different laboratories, using the same method but different equipment to analyze identical samples of test material

In the laboratory, "within-batch" precision is measured using replicate sample or QC analyses and is expressed as the RPD between the measurements. The "batch-to-batch" precision is determined from the variance observed in the analysis of standard solutions or LCSs from multiple analytical batches.

Field precision will be evaluated by the collection of blind field duplicates for chemistry samples at a frequency of one in 20 samples. Field chemistry duplicate precision will be screened against a RPD of 50 percent for sediment samples and 35 percent for water samples. However, no data will be qualified based solely on field homogenization duplicate precision.

Precision measurements can be affected by the nearness of a chemical concentration to the (MDL, where the percent error (expressed as RPD) increases. The equation used to express precision is as follows:

$$RPD = \frac{(C_1 - C_2) x\ 100\%}{(C_1 + C_2)/2}$$

where:

RPD = relative percent difference

C_1 = larger of the two observed values

C_2 = smaller of the two observed values

7.3.2 Accuracy

Accuracy is a measure of the closeness of an individual measurement (or an average of multiple measurements) to the true or expected value. Accuracy is determined by calculating the mean value of results from ongoing analyses of laboratory-fortified blanks, SRMs, and standard solutions. Laboratory-fortified (i.e., matrix-spiked) samples are also measured; this indicates the accuracy or bias in the actual sample matrix.

Accuracy is expressed as percent recovery (%R) of the measured value, relative to the true or expected value. If a measurement process produces results whose mean is not the true or expected value, the process is said to be biased. Bias is the systematic error either inherent in a method of analysis (e.g., extraction efficiencies) or caused by an artifact of the measurement system (e.g., contamination). Analytical laboratories utilize several QC measures to eliminate analytical bias, including systematic analysis of method blanks, LCSs, and independent calibration verification standards. Because bias can be positive or negative, and because several types of bias can occur simultaneously, only the net, or total, bias can be evaluated in a measurement.

Laboratory accuracy will be evaluated against quantitative matrix spike and surrogate spike recovery performance criteria provided by the laboratory. Accuracy can be expressed as a percentage of the true or reference value, or as a %R in those analyses where reference materials are not available and spiked samples are analyzed. The equation used to express matrix spike recovery performance is as follows:

$$\%R = 100\% \; x \; (S - U)/Csa$$

where:

$\%R$ = percent recovery

S = measured concentration in the spiked aliquot

U = measured concentration in the unspiked aliquot

Csa = actual concentration of spike added

The equation used to express surrogate recovery performance is as follows:

$$\%R = 100\% \; x \; (U/S)$$

where:

$\%R$ = percent recovery

S = measured concentration in the spiked aliquot

U = measured concentration in the unspiked aliquot

Field accuracy will be controlled by adherence to sample collection procedures outlined in Section 4 of this QAPP.

7.3.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represents an environmental condition. Assuming those objectives are met, the samples collected should be considered adequately representative of the environmental conditions they are intended to characterize.

7.3.4 Comparability

Comparability expresses the confidence with which one dataset can be evaluated in relation to another dataset. For this program, comparability of data will be established through the use of standard analytical methodologies and reporting formats, and of common traceable calibration and reference materials.

7.3.5 Completeness

Completeness is a measure of the amount of data that are determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

$$C = \frac{(Number\ of\ acceptable\ data\ points) x\ 100}{Total\ number\ of\ data\ points}$$

The DQO for completeness for all components of this project is 100 percent. Data that have been qualified as estimated because the QC criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

7.3.6 Sensitivity

Analytical sensitivities must be consistent with or lower than the regulated criteria values in order to demonstrate compliance with this QAPP. When they are achievable, target RLs specified in this QAPP will be at least a factor of 2 less than the analyte's corresponding regulated criteria value. If RLs lower than criteria are not achieved, the QA/QC Manager will work with the laboratory to ensure that, if at all possible, re-analyses are performed and RLs lower than criteria are achieved.

The MDL is defined as the minimum concentration at which a given target analyte can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. Laboratory MDLs will be used to evaluate the method sensitivity and/or applicability prior to the acceptance of a method for this program. Laboratory RLs are defined as the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions for that particular method.

The sample PQLs will be reported by the laboratory and will take into account any factors relating to the sample analysis that might decrease or increase the RL (e.g., dilution factor, percent moisture, sample volume, sparge volume). In the event that the RL and PQL are elevated for a sample due to matrix interferences and subsequent dilution or reduction in the sample aliquot, causing the SQO criteria to be exceeded, the data will be evaluated by the consultant and the laboratory to determine if an alternative course of action is required or possible. If this situation cannot be resolved readily (i.e., detection limits less than criteria achieved), EPA will be contacted to discuss an acceptable resolution.

7.4 Data Validation and Verification

Laboratory data will be provided in both PDF and EQuIS electronic format. Once data are received from the laboratory, QC procedures will be followed to provide an accurate evaluation of the data quality. The data will be validated in accordance with the project-specific DQOs (Table 4), analytical method criteria, and the laboratory's internal performance standards based on their Standard Operating Procedures. A Stage 2A-level data quality review (equivalent to a QA1 review) will be performed in accordance with EPA National Functional Guidelines (EPA 2008, 2009, 2010). A Stage 4 validation will not be performed. At a minimum the following QC procedures will be evaluated for Stage 2A levels:

- Data completeness
- Holding times
- Method blanks
- Surrogate recoveries
- Detection limits
- RLs
- LCSs
- MS/MSDs
- SRMs

The results of the data quality review, including text assigning qualifiers in accordance with the EPA National Functional Guidelines and a tabular summary of qualifiers will be overseen by the QA/QC Manager, who will conduct final review and confirmation of the validity of the data. A copy of the validation report will be submitted by the QA/QC Manager and will be presented as an appendix to the Data Summary Report.

Laboratory data, which will be electronically provided and loaded into the database, will undergo a 10 percent check against the laboratory hard copy data. Data will be validated or reviewed manually, and qualifiers, if assigned, will be entered manually. The accuracy of all manually entered data will be verified by a second party. Data tables will be exported from EquIS database to Microsoft Excel tables.

8 DATA SUMMARY REPORT

The Data Summary Report will document all activities associated with collecting, compositing, transporting, and chemically analyzing sediment samples. The laboratory data packages will be included as appendices and also submitted in electronic formats. The following will be included in the Data Summary Report:

- Summary of all field activities including a description of any deviations from the approved QAPP
- Locations of sediment sampling stations in state plane coordinates to the nearest foot (Washington North Zone), and in latitude and longitude in degrees and minutes to four decimal places (NAD 83); all vertical elevations of mudline and water surface will be reported to the nearest 0.1 foot
- A project map with actual sampling locations
- A QA/QC narrative for laboratory results
- Summary data results tables
- Presentation of sediment chemistry results and summary as compared to the SQOs, as shown in Table 1

Hard copies of field data will be provided with the Data Summary Report and laboratory analysis results and associated QA/QC data will be available. Results of the laboratory analyses will be submitted to EPA in the Environmental Information Management System format; data will also be submitted to Ecology in the same format. The Data Summary Report will be submitted to EPA within 60 days from receipt of final validated data.

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TABLES

Table 1
Parameters for Analysis, Evaluation Criteria, Methods, and Reporting Limits

	SQO	Analytical Method	Reporting Limits
Conventional Parameters, %			
Gravel	NA	PSEP	0.1
Sand	NA	PSEP	0.1
Silt	NA	PSEP	0.1
Clay	NA	PSEP	0.1
Fines	NA	PSEP	0.1
Total solids	NA	160.3	NA
Total organic carbon	NA	9060	0.02
Metals, mg/kg			
Antimony	150	EPA 6010	5
Arsenic	57	EPA 6010	10
Cadmium	5	EPA 6010	0.4
Chromium	NA	EPA 6010	0.5
Copper	390	EPA 6010	0.4
Lead	450	EPA 6010	5
Mercury	1	EPA 7471	0.1
Nickel	140	EPA 6010	14
Silver	6	EPA 6010	0.6
Zinc	410	EPA 6010	1
Semivolatile Organic Compounds			
Polycyclic Aromatic Hydrocarbons, µg/kg dry weight			
Total LPAH	5,200		
Naphthalene	2,100	8270	20.0
Acenaphthylene	1300	8270	20.0
Acenaphthene	500	8270	20.0
Fluorene	540	8270	20.0
Phenanthrene	1,500	8270	20.0
Anthracene	960	8270	20.0
2-Methylnaphthalene[a]	670	8270	20.0
Total HPAHs	12,000		
Fluoranthene	2,500	8270	20.0
Pyrene	3,300	8270	20.0
Benz(a)anthracene	1,600	8270	20.0
Chrysene	2,800	8270	20.0
Total benzo(b+k)fluoranthenes	3,600	8270	20.0
Benzo(a)pyrene	1,600	8270	20.0
Indeno(1,2,3-cd)pyrene	690	8270	20.0
Dibenz(a,h)anthracene	230	8270	20.0
Benzo(g,h,i)perylene	720	8270	20.0
Chlorinated Hydrocarbons			
1,3-Dichlorobenzene	NA	8270	20.0
1,4-Dichlorobenzene	NA	8270	20.0
1,2-Dichlorobenzene	NA	8270	20.0
1,2,4-Trichlorobenzene	NA	8270	20.0
Hexachlorobenzene	22	8081-PSEP	1.0

Table 1
Parameters for Analysis, Evaluation Criteria, Methods, and Reporting Limits

	SQO	Analytical Method	Reporting Limits
Phthalates			
Dimethyl phthalate	160	8270	20.0
Diethyl phthalate	200	8270	50.0
Di-n-butyl phthalate	1400	8270	20.0
Butyl benzyl phthalate	900	8270	20
Bis(2-ethylhexyl) phthalate	1,300	8270	25
Di-n-octyl phthalate	6,200	8270	20
Phenols			
Phenol	420	8270	20
2-Methylphenol	63	8270	20
4-Methylphenol	670	8270	20
2,4-Dimethylphenol	29	8270	40
Pentachlorophenol	360	8270-SIM	50
Miscellaneous Extractables			
Benzyl Alcohol	73	8270	20
Benzoic Acid	650	8270	400
Dibenzofuran	540	8270	20
Hexachloroethane	NA	8270	20
Hexachlorobutadiene	11	8081-PSEP	1.0
N-Nitrosodiphenylamine	28	8270	20
Pesticides, µg/kg dry weight			
4,4'-DDE	9	8081	1
4,4'-DDD	16	8081	1
4,4'-DDT	34	8081	1
Polychlorinated Biphenyls, µg/kg dry weight			
Aroclor 1016	NA	8082	10
Aroclor 1221	NA	8082	10
Aroclor 1232	NA	8082	10
Aroclor 1242	NA	8082	10
Aroclor 1248	NA	8082	10
Aroclor 1254	NA	8082	10
Aroclor 1260	NA	8082	10
Total PCBs	300	8082	10

Notes:

a = 2-Methylnapthalene is not included in the sum of LPAHs

µg/kg = micrograms per kilogram

EPA = U.S. Environmental Protection Agency

HPAH = high-molecular-weight polycyclic aromatic hydrocarbon

LPAH = low-molecular-weight polycyclic aromatic hydrocarbon

NA = not available

mg/kg = milligrams per kilogram

PCB = polychlorinated biphenyl

PSEP = Puget Sound Estuary Program

SIM = Selective Ion Monitoring

SQO = sediment quality objective

Table 2
Summary of Sediment Stations and Analytes for Natural Recovery Sediment Stability and Protectiveness, and Source Control Monitoring

		Station Coordinates (Washington SP NAD 83 North Zone)		Monitoring Station Type			Parameter	Grain Size	TS and TOC	PCBs	HCB and HCBD	PAHs	Phthalates	DDT and Metabolites	Metals[1]	Archive
							Container	16-oz Plastic	8-oz WM-G	16-oz WM-G	16-oz WM-G	16-oz WM-G	16-oz WM-G	16-oz WM-G	8-oz WM-G	8-oz WM-G
							Preservative	NA	NA	NA	NA	NA	NA	NA	NA	Frozen
OMMP Station ID	Historical Station ID	Northing (ft)	Easting (ft)	Sediment Recovery	Subsurface Protectiveness	Source Control	Laboratory Sample ID									
Segment 5 Channel																
OMMP-1	HY-506	717485.6	1166445	--	--	X	OMMP-1-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-2	HY-509	717100.8	1166655.5	--	--	X	OMMP-2-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-3	HY-512	716625.358	1167142.204	--	X	X	OMMP-3-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-4	HY-514	716331.975	1167453.242	X	--	--	OMMP-4-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-5	HY-516	716172.555	1167603.329	X	--	--	OMMP-5-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-6	HY-519	716034.358	1167747.187	X	--	--	OMMP-6-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-7	HY-522	715850.766	1168068.774	X	--	--	OMMP-7-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-10	HY-523	715666.273	1168322.085	--	X	X	OMMP-10-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-12	HY-525	715498.338	1168265.267	X	--	--	OMMP-12-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-16	HY-527	715149.203	1168604.744	X	--	--	OMMP-16-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-17	HY-528	715231.988	1168824.909	X	--	--	OMMP-17-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-18	HY-530	715086.74	1169178.51	X	--	--	OMMP-18-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-21	HY-533	714736.676	1169585.697	X	--	--	OMMP-21-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-22	HY-535	714644.429	1169874.518	X	--	X	OMMP-22-YYMMDD	X	X	X	X	X	X	X	X	X
Chinook Marina																
OMMP-8	IHS-22	716002.402	1168246.017	X	--	--	OMMP-8-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-9	5125	715975.097	1168358.425	X	--	--	OMMP-9-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-11	IHS-21	715954.52	1168630.904	X	--	--	OMMP-11-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-13	IHS-8	715751.932	1168513.507	X	--	--	OMMP-13-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-14	5126	715695.676	1168627.633	X	--	--	OMMP-14-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-15	IHS-23	715574.693	1168772.445	X	--	--	OMMP-15-YYMMDD	X	X	X	X	X	X	X	X	X
Navy Bank Nearshore																
OMMP-19	2S	714798.688	1169084.511	X	--	--	OMMP-19-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-20	3S	714745.565	1169227.108	X	--	--	OMMP-20-YYMMDD	X	X	X	X	X	X	X	X	X
Tacoma Public Nearshore																
OMMP-24	402	714464.738	1170227.295	X	--	--	OMMP-24-YYMMDD	X	X	X	X	X	X	X	X	X
Segement 4 Channel																
OMMP-23	HY-536	714771.4	1169976.32	--	--	X	OMMP-23-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-25	HY-421-2	714235	1171115.4	--	--	X	OMMP-25-YYMMDD	X	X	X	X	X	X	X	X	X
American Nearshore																
OMMP-26	AMCO-C24	713949	1171516	X	--	--	OMMP-26-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-27	AMCO-C11b	713852.272	1171537.975	X	--	--	OMMP-27-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-28	AMCO-C11b	713887	1171559	X	--	--	OMMP-28-YYMMDD	X	X	X	X	X	X	X	X	X
Simons Nearshore																
OMMP-31	401-C	713813.816	1171905.057	X	--	--	OMMP-31-YYMMDD	X	X	X	X	X	X	X	X	X

Table 2
Summary of Sediment Stations and Analytes for Natural Recovery Sediment Stability and Protectiveness, and Source Control Monitoring

		Station Coordinates (Washington SP NAD 83 North Zone)		Monitoring Station Type			Parameter	Grain Size	TS and TOC	PCBs	HCB and HCBD	PAHs	Phthalates	DDT and Metabolites	Metals[1]	Archive
							Container	16-oz Plastic	8-oz WM-G	16-oz WM-G	16-oz WM-G	16-oz WM-G	16-oz WM-G	16-oz WM-G	8-oz WM-G	8-oz WM-G
							Preservative	NA	NA	NA	NA	NA	NA	NA	NA	Frozen
OMMP Station ID	Historical Station ID	Northing (ft)	Easting (ft)	Sediment Recovery	Subsurface Protectiveness	Source Control	Laboratory Sample ID									
Simons Channel																
OMMP-29	--	714079.09	1171791.74	X	--	--	OMMP-29-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-30	401-D	713970.935	1171949.383	--	X	--	OMMP-30-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-32	--	713855.831	1172172.339	X	--	--	OMMP-32-YYMMDD	X	X	X	X	X	X	X	X	X
Sound Refining Schoaling Area																
OMMP-33	HY-S44-1	713817.187	1172566.16	X	--	X	OMMP-33-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-35	HY-S44-5	713619.074	1173053.427	X	--	X	OMMP-35-YYMMDD	X	X	X	X	X	X	X	X	X
Buffelen Embankment																
OMMP-34	BEA-C04-1	713391.255	1172706.309	X	--	--	OMMP-34-YYMMDD	X	X	X	X	X	X	X	X	X
Murray-Pacific Channel																
OMMP-36	HY-321-1	713273.138	1173320.585	--	X	X	OMMP-36-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-37	301	713127.185	1173456.273	X	--	--	OMMP-37-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-38	HY-322-2	712708.587	1173906.12	--	X	X	OMMP-38-YYMMDD	X	X	X	X	X	X	X	X	X
OMMP-39	HY-322-4	712370.21	1174331.91	--	X	X	OMMP-39-YYMMDD	X	X	X	X	X	X	X	X	X
Wasser Winters Nearshore																
OMMP-40	103	708711.526	1178726.323	X	--	--	OMMP-40-YYMMDD	X	X	X	X	X	X	X	X	X

Notes:

-- = not applicable

1 = Metals parameters include arsenic, cadmium, chromium, copper, mercury, nickel, lead, silver, and zinc.

DDT = dichlorodiphenyl-trichloroethane

ID = identification

ft = foot

HCB = hexachlorobenzene

HCBD = hexachlorobutadiene

NA = not applicable

oz = ounce

PAH = polycyclic aromatic hydrocarbons

PCB = polychlorinated biphenyls

TS = total solids

TOC = total organic carbon

Washington SP NAD 83 = Washington State Plane North American Datum 1983

WM-G = wide-mouth glass jar

Table 3
Guidelines for Sample Handling and Storage

Parameter	Sample Size (g)	Container Size and Type[a]	Holding Time	Preservative
Metals	50	8-oz glass	6 months; 28 days for mercury[b]	Cool/4 °C
				Freeze[c]
Semivolatile organic compounds	150	16-oz glass	14 days until extraction	Cool/4 °C
			1 year until extraction	Freeze/-18 °C
			40 days after extraction	Cool/4 °C
Pesticides	150	16-oz glass	14 days until extraction	Cool/4 °C
			1 year until extraction	Freeze/-18 °C
			40 days after extraction	Cool/4 °C
Polychlorinated biphenyls	150	16-oz glass	14 days until extraction	Cool/4 °C
			1 year until extraction	Freeze/-18 °C
			40 days after extraction	Cool/4 °C
Total solids	50	From metals container	14 days	Cool/4 °C
			6 months	Freeze -18 °C
Total organic carbon	125	From metals container	14 days	Cool/4 °C
			6 months	Freeze -18 °C
Grain size	500	16-oz plastic	6 months	Cool/4 °C

Notes:

a = All sample containers will have lids with teflon inserts.

b = Per SW-846, longer hold times may be appropriate if it can be demonstrated that the reported analyte concentrations are not adversely affected by preservation, storage, and analyses performed outside the recommended holding times.

c = Samples will be analyzed for mercury before freezing.

g = gram

oz = ounce

°C = degrees Celsius

Table 4
Data Quality Objectives

Parameter	Precision	Accuracy	Completeness
Grain size	± 20% RPD	NA	95%
Total solids	± 20% RPD	NA	95%
Metals	± 20% RPD	80 to 120%	95%
Total organic carbon	± 20% RPD	75 to 125% R	95%
Polychlorinated biphenyls	± 50% RPD	50 to 150% R	95%
Pesticides	± 50% RPD	50 to 150% R	95%
Semivolatile organic compounds	± 50% RPD	50 to 150% R	95%

Notes:
NA = not applicable
RPD = relative percent difference
R = recovery

Table 5
Laboratory QA/QC Sample Analysis Summary

Analysis Type	Initial Calibration	Ongoing Calibration	Replicates	Matrix Spikes	SRM/LCS	Matrix Spike Duplicates	Method Blanks	Surrogate Spikes
Grain size	Each batch [a]	NA	1 per 20 samples	NA	NA	NA	NA	NA
Total solids	Each batch [a]	NA	1 per 20 samples	NA	NA	NA	NA	NA
Total organic carbon	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA
Metals	Daily or each batch [b]	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	Each batch	NA
Polychlorinated biphenyls	As needed [c]	1 per 10 samples	NA	1 per 20 samples	1 per 20 samples	1 per 20 samples	Each batch	Every sample
Pesticides	As needed [c]	1 per 10 samples	NA	1 per 20 samples	1 per 20 samples	1 per 20 samples	Each batch	Every sample
Semivolatile organic compounds	As needed [c]	Every 12 hours	NA	1 per 20 samples	1 per 20 samples	1 per 20 samples	Each batch	Every sample

Notes:

a = Calibration and certification of drying ovens and weighing scales are conducted bi-annually.

b = Initial calibration verification and calibration blank must be analyzed at the beginning of each batch.

c = Initial calibrations are considered valid until the ongoing continuing calibration no longer meets method specifications. At that point, a new initial calibration is

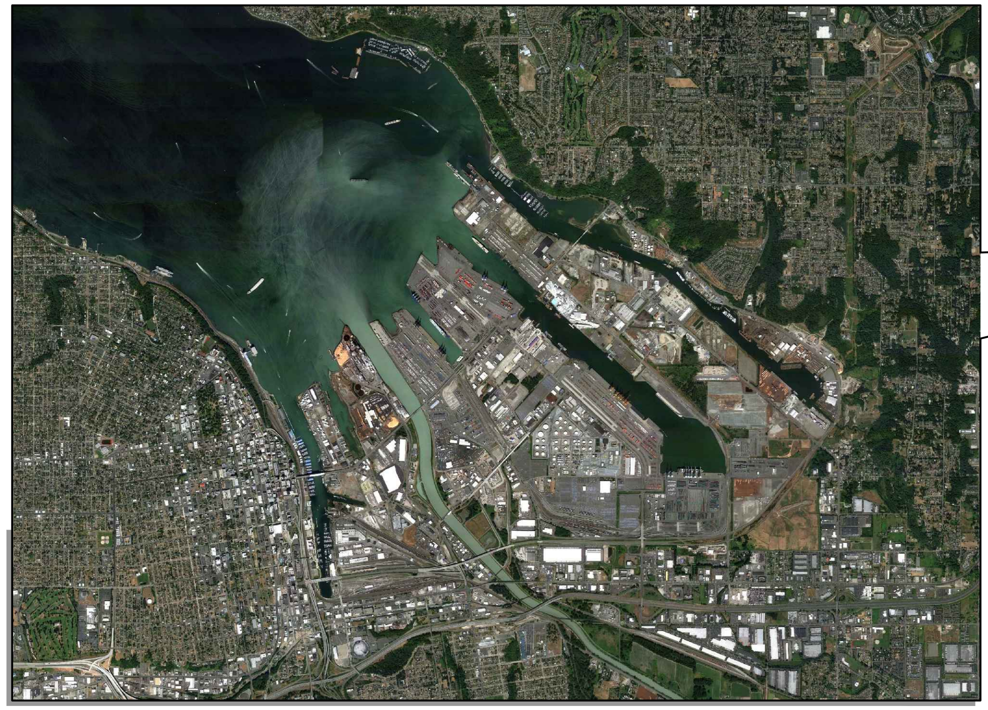
LCS = laboratory control sample

NA = not applicable

QA/QC = quality assurance/quality control

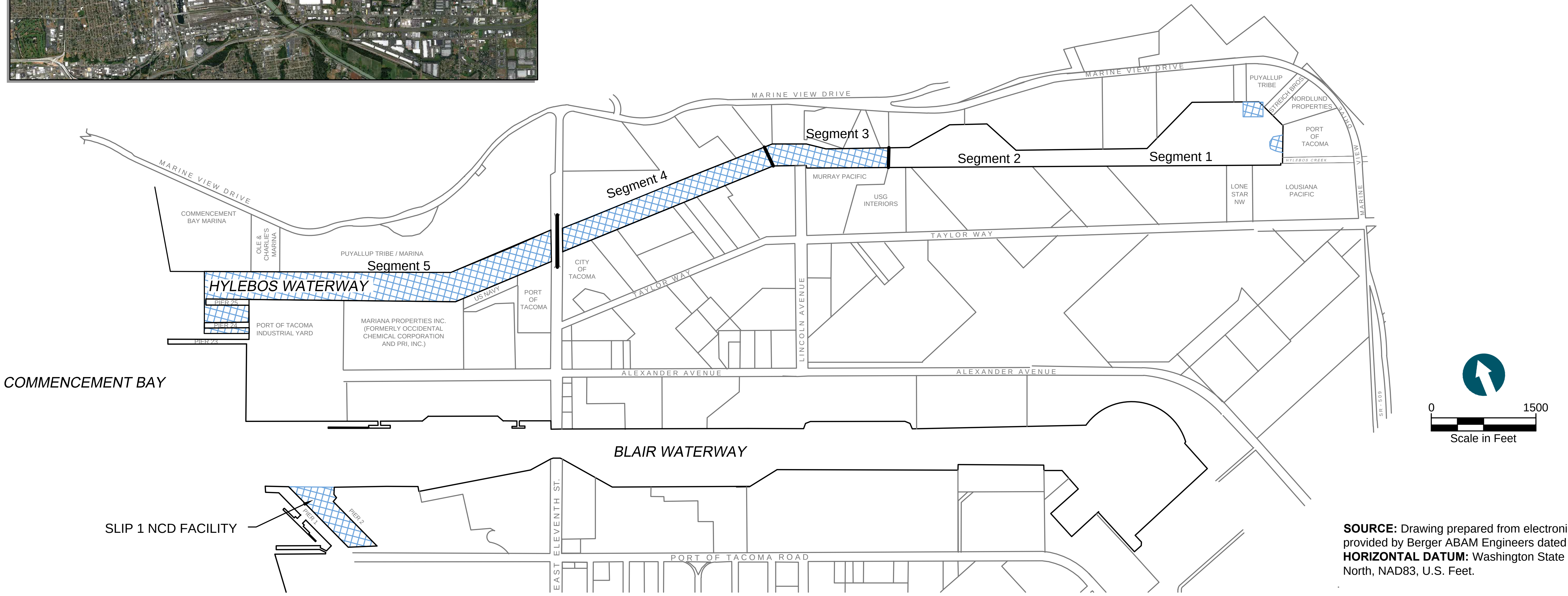
SRM = standard reference material

FIGURES



LEGEND:

▨ Project Limits of the Hylebos Segment 3 to 5 Cleanup Project



SOURCE: Drawing prepared from electronic file provided by Berger ABAM Engineers dated 2003.
HORIZONTAL DATUM: Washington State Plane North, NAD83, U.S. Feet.

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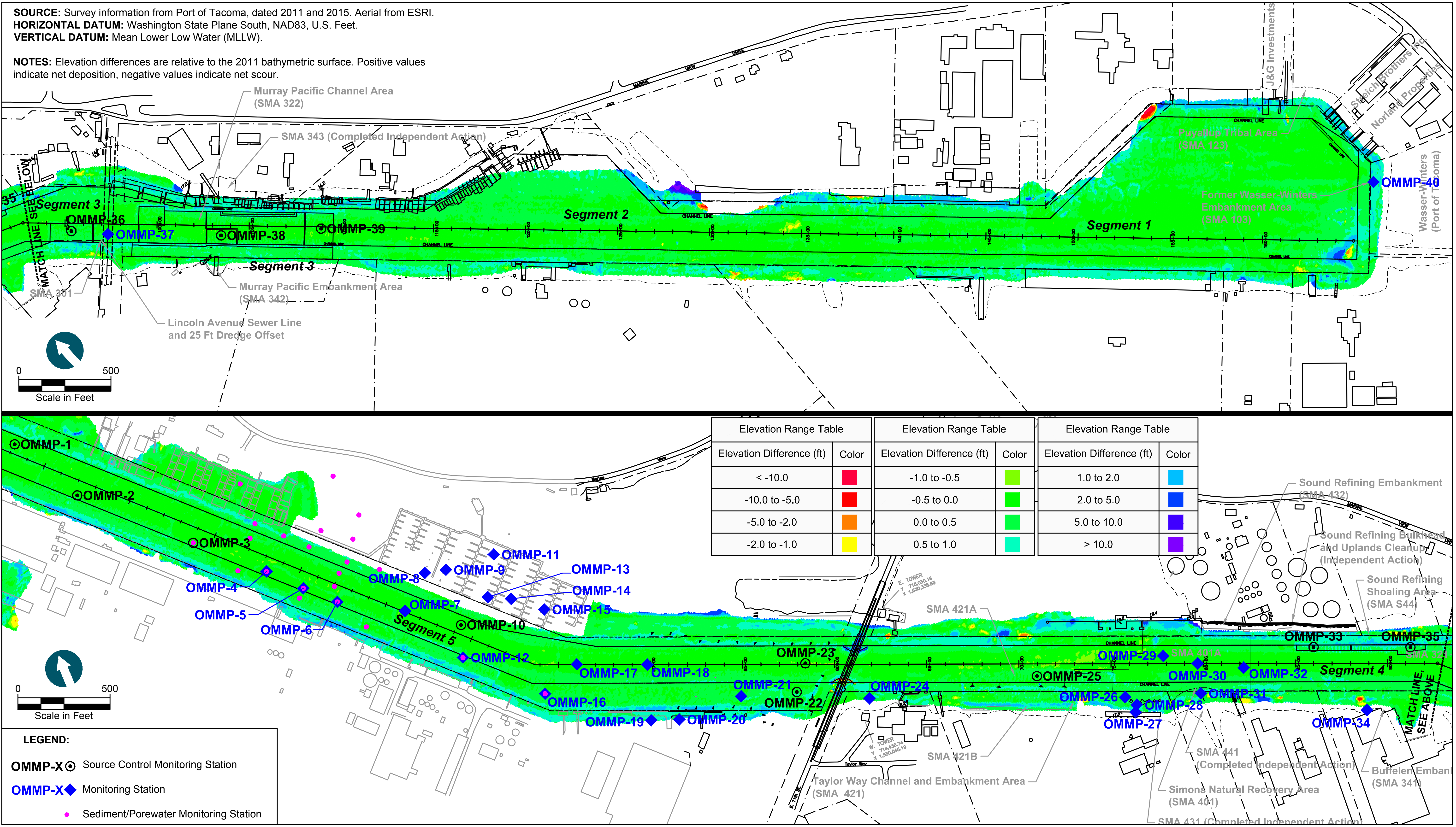
Aug 13, 2015 8:29am chewett

ANCHOR QEA

Figure 1
Vicinity Map
Quality Assurance Project Plan
Mouth of Hylebos Waterway (Segments 3, 4, and 5)

SOURCE: Survey information from Port of Tacoma, dated 2011 and 2015. Aerial from ESRI.
HORIZONTAL DATUM: Washington State Plane South, NAD83, U.S. Feet.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

NOTES: Elevation differences are relative to the 2011 bathymetric surface. Positive values indicate net deposition, negative values indicate net scour.



Elevation Range Table	
Elevation Difference (ft)	Color
< -10.0	🟥
-10.0 to -5.0	🟥
-5.0 to -2.0	🟧
-2.0 to -1.0	🟨

Elevation Range Table	
Elevation Difference (ft)	Color
-1.0 to -0.5	🟩
-0.5 to 0.0	🟩
0.0 to 0.5	🟩
0.5 to 1.0	🟦

Elevation Range Table	
Elevation Difference (ft)	Color
1.0 to 2.0	🟦
2.0 to 5.0	🟦
5.0 to 10.0	🟪
> 10.0	🟪

LEGEND:

OMMP-X ⊙	Source Control Monitoring Station
OMMP-X ◆	Monitoring Station
●	Sediment/Porewater Monitoring Station

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Nov 03, 2015 8:39am chewett

ANCHOR QEA

Figure 2
OMMP Sediment Sampling Locations
Quality Assurance Project Plan
Mouth of Hylebos Waterway (Segments 3, 4, and 5)